MACHINERY.

Vol. 5. **March, 1899.** **No. 7.**

TESTS UPON STEAM PUMPS AND INJECTORS.

A COLLECTION OF VALUABLE DATA UPON PUMPS OF DIFFERENT STYLES AND SIZES.

STEAM PUMP TESTS.

H. E. WALTON.

Several articles have appeared in the technical press during the past two or three years, containing data relating to the steam consumption of the ordinary steam pump.

The excessive amount of steam required to operate the steam pump, as shown by the articles, has impressed the progressive manufacturer to such an extent that he has adopted more economical apparatus, such as electric and power pumps.

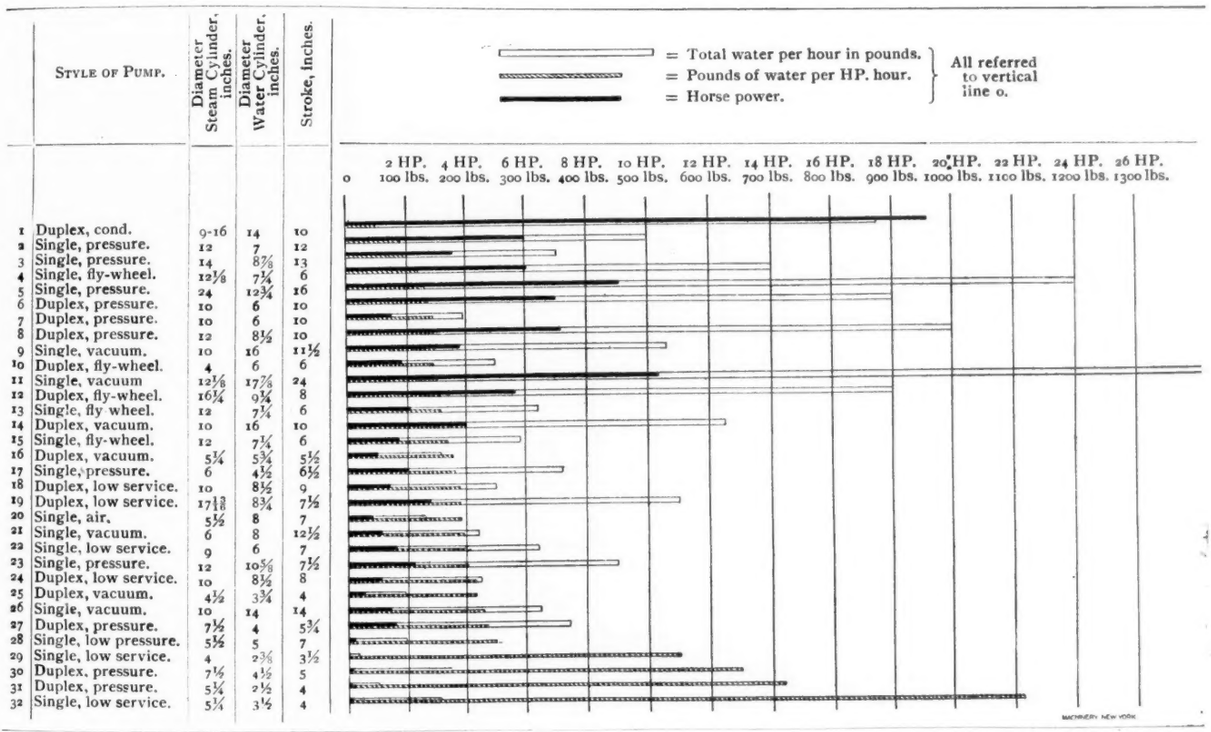
Many manufacturers have installed modern engines under a guarantee of low steam consumption, and then have ordered condensing apparatus, or boiler f ed pumps, with utter disregard of the share they have in the cost of operating their plant.

operate the pump in question. The horse-power was obtained from the indicator card, the water per horse-power per hour from the amount of exhaust steam which was condensed while the indicator cards were taken, and the total water per hour by the product of these items. A portable condenser was used to condense the exhaust steam, and was made of a coil of three-inch copper pipe placed in a large wooden barrel. This barrel was kept filled continuously with cold water, while the pipe was connected to the exhaust pipe of the pump.

Pump No. 1 is compound condensing; the result does not include the steam used by the vacuum pump, which is given under No. 25.

Nos. 2 and 7 are used for boiler purposes, Nos. 6 and 8 for

GRAPHICAL REPRESENTATION OF RESULTS OF PUMP TESTS, STEAM CONSUMPTION.


= Total water per hour in pounds.
= Pounds of water per HP. hour.
= Horse power.
All referred to vertical line o.
0
2 HP. 100 lbs.
4 HP. 200 lbs.
6 HP. 300 lbs.
8 HP. 400 lbs.
10 HP. 500 lbs.
12 HP. 600 lbs.
14 HP. 700 lbs.
16 HP. 800 lbs.
18 HP. 900 lbs.
20 HP. 1000 lbs.
22 HP. 1100 lbs.
24 HP. 1200 lbs.
26 HP. 1300 lbs.

	Style of Pump.	Diameter Steam Cylinder. inches.	Diameter Water Cylinder. inches.	Stroke, Inches.
1	Duplex, cond.	9-16	14	10
2	Single, pressure.	12	7	12
3	Single, pressure.	14	8⅜	13
4	Single, fly-wheel.	12⅛	7¼	6
5	Single, pressure.	24	12¾	16
6	Duplex, pressure.	10	6	10
7	Duplex, pressure.	10	6	10
8	Duplex, pressure.	12	8½	10
9	Single, vacuum.	10	16	11½
10	Duplex, fly-wheel.	4	6	6
11	Single, vacuum	12⅛	17⅞	24
12	Duplex, fly-wheel.	16¼	9¾	8
13	Single, fly wheel.	12	7¼	6
14	Duplex, vacuum.	10	16	10
15	Single, fly-wheel.	12	7¼	6
16	Duplex, vacuum.	5¼	5¾	5½
17	Single, pressure.	6	4½	6½
18	Duplex, low service.	10	8½	9
19	Duplex, low service.	17 1/8	8¾	7½
20	Single, air.	5½	8	7
21	Single, vacuum.	6	8	12½
22	Single, low service.	9	6	7
23	Single, pressure.	12	10⅝	7½
24	Duplex, low service.	10	8½	8
25	Duplex, vacuum.	4½	3¾	4
26	Single, vacuum.	10	14	14
27	Duplex, pressure.	7½	4	5¾
28	Single, low pressure.	5½	5	7
29	Single, low service.	4	2⅜	3½
30	Duplex, pressure.	7½	4½	5
31	Duplex, pressure.	5¼	2½	4
32	Single, low service.	5¼	3½	4

It seems necessary to offer additional evidence of this waste of energy, by placing before the readers of this paper the results of tests on pumps of several different makes, which are used on work requiring vacuum, compressed air, heavy pressure, and low service.

These tests were made on the pumps while they were performing the regular work required of them in the various conditions of manufacturing. They are strictly commercial, without the extreme refinements of a scientific test, as the desire was to obtain the actual cost of operating these machines. It is this item which affects the balance sheet at the end of the year. No attempt was made to put the pumps in first-class condition; the tests were made as the pumps happened to be at that time, with ordinary wear.

In the accompanying diagram the tests have been arranged graphically as regards the horse-power per hour, water per horse-power per hour, and the total water per hour required to

elevator work, No. 10 i compressing air, and N 27 for high pressures.

Nos. 28, 29, 30, 31, and 32 developed only a small per cent. of a horse-power.

Each rectangle is measured from the vertical line O. Each space to the right represents one hundred pounds of water, or two horse-power. This has been arranged for convenience only, and not for any relation of steam consumption to the horse-power.

PUMP AND INJECTOR TESTS.

Collected from Various Sources.

WM. WALLACE CHRISTIE.

Tests on a Worthington Duplex steam pump, February 9, 1892. Slip not accounted for. Diameter of steam cylinder, 6 inches; Diameter of water cylinder, 4 inches; diameter of piston rod 1⅛

inches; length of stroke, 5 inches. Temperature of water in main, 39.2° F.

Data from Three Tests.	No. 1.	No. 2.	No. 3.
Ind. horse power, one side	.6949	.8618	1.1362
" " " other side	.7234	.8139	1.2154
" " " total	1.4183	1.6757	2.3516
Quality of steam	99.7%	99.8%	99.7%
Observed steam pressure, lbs	75.5	58.5	65.6
Feed water, lbs	188.5	130	137.34
Cubic feet water delivered	282.	163.	107.5
Pounds water delivered	17621	10167	6706
Water per pound feed water	93.4	78.2	48.8
Total head in feet	25.5	50.	70.
Pounds of water pumped per I. H. P. per hour	12497	6069	2853
Gallons " " " " " minute	49.50	24.2	17.08
" " " " " hour	2970	1452	1024
Feed water per hour	377	260	412
Gallons per lb., feed water or steam	7.87	5.58	2.48
Pounds of water per lb. steam	65.32	46.31	20.58

Mr. J. A. Jeckell, in "Engineering" (London), 1898, p. 734 (June), reports these tests made with duplex pumps—direct acting feed water—put in thorough repair before testing:

	Pump No. 1.	Pump No. 2.	Boiler Feed Pump. No 3.	Boiler Feed Pump. No. 4.
Lift, feet	18	18	.....	.....
Delivery, feet	22	22	Into boiler 160 lbs.	Into boiler 160 lbs.
Lbs. of steam per hour	583	730	340	390
Water delivered per hour, galls.	18251	13384	400	373
Lbs. water pumped per lb. of steam	270.83	152.75	9.80	7.97

F. Merriam Wheeler, in "Engineering" (London), Dec. 23, 1898, p. 812, gives these results of tests made on a Blake "simplex" double acting feed pump:

High pressure side, 6" dia. steam cyl., 3½" dia. water cyl., 8" stroke.

Low pressure side, 9" dia. steam cyl., 3½" dia. water cyl., 8" stroke.

When operated as a compound engine:

The indicated horse-power in H.P. cylinder = 2.54. and in L.P. cylinder = 3.07. Total, 5.61 H.P.

Steam pressure, gage, 112.5.

Water per I.H.P. per hour—52.04 lbs.

When using 6" cyl. as a simple engine:

The indicated horse-power was 3.961.

Steam pressure, gage, 67.5 lbs.

Water per I.H.P. per hour, 93.41 lbs.

Total head for each case, 17 feet.

The Battle Creek Steam Pump Co. reports tests made by the R. W. Hunt Engineering Co. as follows:

Marsh compound pump, 10 & 16 x 9¼ x 16, in Mass. Inst. Tech. Laboratory.

Gage pressure, 78.3 lbs.

Horse-power output, 30.74.

Steam per H.P. per hour, 45.3 lbs.

Marsh compound pump, 10 & 16 x 10 x 16, at factory:

Gage pressure, 91 lbs.

Water pressure, 97.8 lbs.

Suction lift, 14 feet.

H.P. developed, 29.02.

Steam per H.P. per hour, 46 lbs.

Tests made November, 1891, by W. W. C., with a Hancock inspirator. Diameter suction pipe, ¾ inch; diameter discharge pipe, ¾ inch; diameter steam orifice, .20 inch; diameter water orifice, 0.152 inch.

Three Tests.	No. 1.	No. 2.	No. 3.
Water supplied per hour	1633	2037	2034
Water delivered per hour	1770	2214	2200
Wet steam per hour	137	177	166
Pounds of water delivered to 1 lb. wet steam	11.92	11.51	12.35
Pounds of water delivered to 1 lb. dry steam	12.33	11.87	12,63
Temperature of water supply	71	63	66
Temperature of water as delivered	158.5	152.2	151.2
Absolute steam pressure on inspirator	80.3	86.2	86.75
Total head in feet	27.39	118.45	223.10

The Bulletin of the University of Wisconsin, June, 1897, gives these results, vouched for by Prof. Storm Bull:

Name.	Lbs. of Water per lb. of Steam.*	Lowest Pressures under which Injector will work. Feed 50°.	Feed 90°.	Feed 110°	Limit of Feed Temperature, deg. F.
Monitor	10.36 to 13.19	..	22	..	102
Sellers	10.98 to 16.17	..	25	19	125
Penberthy	10.50 to 12.31	38	35	..	94
Metropolitan	9.37 to 11.13	4	4	5	118
Korting	9.11 to 9.78	3[1]	3[1]	3[1]	130
World	8.62 to 9.31	3[1]	3[1]	3[1]	130
Excelsior	7.57 to 8 20	8	..	..	87
Sherwood	7.50 to 8.68	12	..	9	122
United States	9.59 to 9.78	40[2]	..	..	....

* Whole range of experiments.
1 Or lower.
Feed 70°

OPERATION OF INJECTORS WITH FEED WATER AT 50°.

Name.	Steam Pipe, ins	Gallons per Hour.	Average Water per lb. Steam.	Temperature of Delivery.	Limit of Suction in ins. of Mercury.
Sellers	1¾	615	12.17	137	20.5
Sherwood	1	579	7.83	179	21.25
Metropolitan	1	645	11.07	144	17.75
Monitor	1	511	12.37	175	12.5
Korting	1¼	508	9.47	159	18 5
Penberthy	¾	478	12.03	137	16.5
World	¾	370	9.22	160	19.5
Excisior	¾	286	7.95	175	14.25

* * *

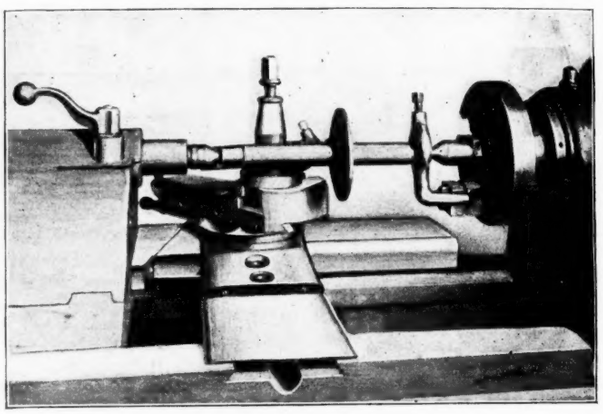
A TRICK.

W. A. Waterman.

This scheme pertains solely to grinder and polisher flanges. Being foreman in quite a large establishment, where these flanges are made, I have had considerable bother with them.

They were of a diameter that could not be faced judiciously in a chucking machine, and an arbor was used in a lathe. The back of the flange had an angle of fifteen degrees, and when the foot stock of the lathe was set over sufficiently to obtain this angle, I found the arbor had such a motion on the centers that it would not last longer than to do twenty or thirty flanges, and the transverse motion of the tail of the dog in the slot of the face plate was three-quarters of an inch on each side, which soon destroyed the plate.

Now, here comes the trick to overcome these difficulties and at the same time to enable the power cross feed to be used. First, we planed up a pair of wedges of a sufficient length to cover one-



DEVICE FOR FACING GRINDER FLANGES.

half the diameter of the flanges. Then we planed a spot on the foot stock and screwed one wedge solid to it, with the wide side toward the front of the lathe. The other wedge was screwed solid to a planed spot on the cross feed slide at the same height as the one on the foot stock, and with the wide end toward the back.

As I before said, the back of the flanges were to be fifteen degrees, so we planed the wedges fifteen degrees. Then, we set the compound rest around sufficiently to allow us to feed away from the foot stock quite rapidly, and tried a flange. With flange in position we ran the tool down with the cross-feed screw, and out with the compound rest, keeping the faces of the wedges together. When we obtained the required chip we put on the friction of the cross feed and awaited results, and found that one wedge traveling on the face of the other forced the cross-feed rest away from the foot stock, at an angle to correspond to the angle of these faces, which gave just what was wanted.

The above photograph will assist the readers to understand the method that was used.

* * *

The Swedish Government has recently been collecting data relative to the number of telephones in use in the different countries in the world, using the latest available information, some of which, however, is rather ancient. Out of a total in the world of 1,288,000, the United States has over 60 per cent., and Germany comes next with three times as many as Great Britain and Ireland. Cuba has 1,818, the Philippines 452 and the little republic of Switzerland nearly 29,000, or more than France and half as many as Great Britain.

TURRET FORMING TOOL.

H. GOLDSMITH.

In use in one of the large tool shops in Cincinnati is a turret forming tool, the application of which I will explain, and why I call it such. The number, variety of usages, and the amount of work which this tool is capable of producing, are well worth a few moments of study.

Sketches and explanations herewith give an idea of how a bevel gear pinion and wheel are turned or formed.

Tool block A, Fig. 1 (either of cast or machinery steel), has a shank, B, of a diameter to fit snugly the hole in turret. The sides of block A are planed different distances from the center, allowing a capacity for four different diameters of gears, but in this case drawing shows only for two diameters.

Sides C and D, Fig. 2, are used for turning bevel gear pinions. E and F are used for turning bevel gear wheels; a dovetailed groove is planed the entire length of sides C, D, E, and F. Block A has a hole bored centrally through its entire length, into which a pilot, H, with a shank, is fitted. The shank of pilot corresponds to diameter of bore in gear, and is hardened and ground. The pilot is held firmly in position by set screws, J and J'.

K and K' are attachments which are clamped to block A and held firmly by clamping bolts, L and L', having tapered ends to fit the grooves on sides C, D, E and F.

Fig. 2 shows front view of tool block A and attachments K and K'. The latter have grooves cut in their front ends of a width corresponding to width of cutter, grooves being cut so as to bring cutting edges of cutter directly in line with center of pilot, H and the cutters are firmly held in position by set screws, as shown.

Dotted lines of pinion give an idea of how the cutters should be set. Cutters have the proper angles to correspond to gear; cutter N, which roughs the outside diameter and face of bevel gear pinion, is set to allow a finishing cut to be run over it by tool shown in Figs. 9 and 10, explanation of which will follow.

Figs. 3 and 4 show the setting of the attachments K and K' for roughing bevel gear wheel; sides E and F are used. No extra attachments are necessary, excepting new cutter for the different angles, and, perhaps, another pilot, H, if the bore is of a different diameter.

Figs. 6 and 7 give an idea of the shape and size of cutters necessary for bevel gears, of 4 inch and 8 inch. respectively, with 1⅜-inch face. For roughing these cutters can be made with serrated edges, and for hard cast-iron they are of great assistance to get beneath the scale.

Figs. 9 and 10 show the mounting of the finishing tools. In Fig. 10 you will notice that the cutting edge of cutter is set ⅛ inch back of center; in this manner no clearance is necessary to be ground upon the tool. As a finishing tool for bevel gears I have seen none to equal it. The blanks, when removed from lathe and put upon a mandril, and placed between centers, run perfectly true.

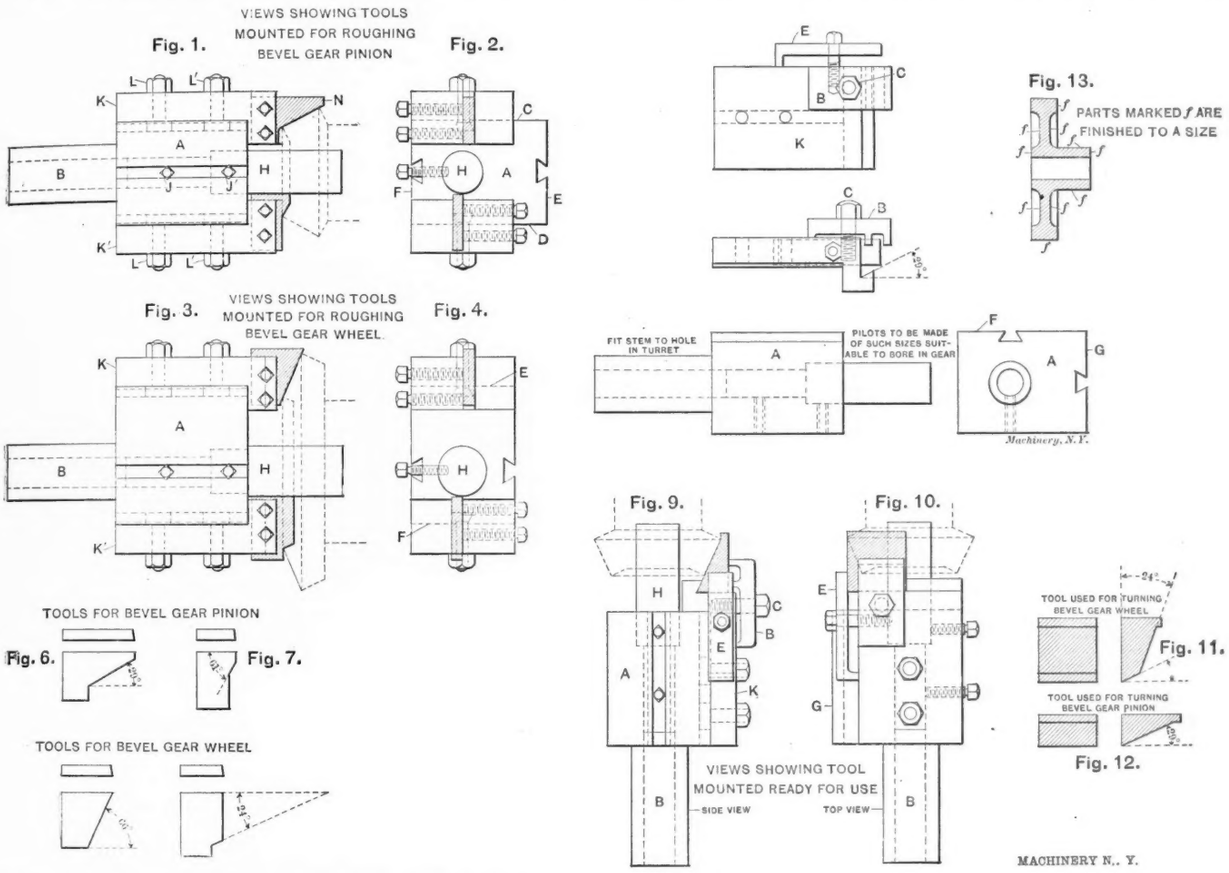
Block A, Figs. 9 and 10, is of a design similar in construction to block A, in Figs. 1, 2, 3 and 4. Attachment K is held to block A by bolts similar in construction, as described in Fig. 1.

On the front end of K is a groove planed its entire width at an angle of about 29 degrees. The end of the cutter is beveled at the same angle, as in Figs. 11 and 12. B is a clamp for the cutter, held firmly by screw C. Tightening screw C forces clamp B down upon the cutter, the end of same being beveled, and fitting into the beveled groove planed in K. This causes the center to slide back and to butt firmly against the solid metal, this being essential to prevent chattering. E is also a clamp, and a means of adjusting the cutter in a longitudinal direction.

Fig. 11 is the cutter used for bevel wheels. For turning same, it is only necessary to remove K from side F to side G, clamp same firmly in position, and mount the cutter shown in Fig. 11 one-eighth inch back of the center; clamp same solidly in position, and the tool is ready for operation.

You will notice in Figs. 11 and 12, views showing the cutters, that no clearance is given in either case, and none is required; to sharpen same, it is only necessary to grind on front face The little offsets shown on cutters, Figs. 11 and 12, turn the gear to its proper diameter.

Tool shown in Fig. 1 is one that can be adapted for a great variety of work, such as turning the taper and outside diameter, in friction gears, apron knurls, etc. Fig. 13 conveys an idea of the kind of work which can be done with these tools, and done in half the time required on an engine lathe.


VIEWS SHOWING TOOLS MOUNTED FOR ROUGHING BEVEL GEAR PINION
Fig. 1.
Fig. 2.
VIEWS SHOWING TOOLS MOUNTED FOR ROUGHING BEVEL GEAR WHEEL.
Fig. 3.
Fig. 4.
TOOLS FOR BEVEL GEAR PINION
Fig. 6.
Fig. 7.
TOOLS FOR BEVEL GEAR WHEEL
Fig. 13.
PARTS MARKED f ARE FINISHED TO A SIZE
FIT STEM TO HOLE IN TURRET
PILOTS TO BE MADE OF SUCH SIZES SUITABLE TO BORE IN GEAR
Machinery, N.Y.
Fig. 9.
Fig. 10.
VIEWS SHOWING TOOL MOUNTED READY FOR USE
SIDE VIEW
TOP VIEW
TOOL USED FOR TURNING BEVEL GEAR WHEEL
Fig. 11.
TOOL USED FOR TURNING BEVEL GEAR PINION
Fig. 12.
MACHINERY N.. Y.

THE HORSE-POWER OF MACHINE TOOLS.

THE POWER REQUIRED TO DRIVE MACHINE TOOLS AND SHAFTING—A SUMMARY OF THE RESULTS OF MANY TESTS.

C. H. BENJAMIN.

One important problem, which presents itself to the man who is about to equip a machine shop, large or small, is the determination of the amount of power which will probably be required.

Until within a few years this has been largely a matter of guess work, but to-day quite an amount of data on this subject is more or less available. It is the purpose of this article to gather together and put in convenient form some such data.

Probably the most complete experiments on the power required to drive heavy machine tools are those made at the Baldwin Locomotive Works, and published in the "American Machinist" in 1896. For full details of these experiments and others of like character, it is sufficient to refer the readers to the files of that paper for the year mentioned. It is enough for our purpose to say that the machines mentioned were driven by independent motors, and that the power was measured by electrical instruments.

Table I, shown below, gives a summary of the results.

The amounts of power absorbed may seem rather large to some, but it must be remembered that the machines are large and that in the Baldwin Works tools are not allowed to loaf.

TABLE I.

KIND OF MACHINES.	Size.	Material Cut.	Number of Tools.	HORSE POWER. Motor and Shaft.	Empty Machine.	Total Cutting. Min.	Max.	Ave.
Wheel lathe	84 in.	Cast iron.	2	.....	.....	2.9	7.9	6.1
" "	84 in.	" "	2	.....	.....	4.2	5.8	5.1
" "	84 in.	" "	2	....	1.5	5.3	6.2	5.8
Boring mill.....	78 in.	" "	1	.....	.....	4.3	4.7	4.5
" "	78 in.	" "	1	.....	.....	5.5	7.1	6.5
Slotting machine.	36 in.x12 in.	Wro't iron.	1	1.5	1.5	4.4	6.7	5.3
Sellers planer....	62 in.x35 ft.	" "	2	4.4	11.4	20.6	21.6	21.1
" "	62 in.x35 ft.	" "	2	.....	5.8	23.0	26.0	24.5
Planer ...	36 in.x12 ft.	" "	2	2.7	3.0	11.3	13.8	12.5
Bement planer...	24 in.x13 ft.	Steel.	2	1.95	4.3	.....	.....	8.0
Sellers planer....	36 in.x18 ft.	Wro't iron.	2	3.2	4.3	.....	.....	16.7
" "	56 in.x35 ft.	" "	2	4.6	9.9	13.0	13.7	13.3
" "	56 in.x24 ft.	" "	2	4.56	6.0	16.0	17.7	16.8
Wheel lathe.....	90 in.	Cast steel.	2	1.43	2.1	.....	.....	6.38
Bement drill.....	21 ft.	Wro't iron.	3— ⅞ in.	2.1	2.6	3.6	4.8	4.2
" "	21 ft.	" "	3—2 in.	2.1	2.6	.....	.....	8.0
Harrington drill..	22 ft.	" "	2—1 in.	1.1	1.45	2.7	5.15	3.7
Radial drill.....	42 in.	" "	1—2 in.	0.96	1.1	.....	.....	2.1
Boring mill.....	4 ft. 6 in.	Cast steel.	1	2.1	2.4	.....	.....	4.6
" "	5 ft. 6 in.	Cast iron.	1	1.6	2.4	4.2	4.8	4.4
Slotting machine.	40 in.x15 in.	Wro't iron.	1	1.8	2.2	.....	.....	7.3
Shaping machine.	19 in. str.	" "	1	1.6	1.8	4.8	9.7	7.3

The figures given in the table for the power required to run the planing machines empty do not include the maximum horse power at the instant of reversal, but represent the average forward and return of the empty table.

One fact is apparent at a glance, and that is the relatively large amount of power consumed by the motor and countershaft.

An average of the sixteen cases where this power was measured gives 2.35 H.P. for motor and shaft, and 8.85 H.P. for the total average horse power of the working machine. In other words, the motor and shaft absorb nearly 25 per cent. of the total power used, and this when the machines are run at their full capacity.

This seems to dispose of the extravagant claims for efficiency made by some electrical enthusiasts.

Planers and Shapers.

The tests shown in Table II., Nos. 1 to 9, were made at different times on the same planer, at the Case School. The horse powers given are net, and do not include the counter shaft. The friction of the latter was from .2 to .3 H.P.

The power required to run the empty table depends upon the

TABLE II.

No.	Kind of Machine	Size.	Material Cut.	Pounds Metal per Hour.	HORSE POWER. Empty Forward.	Empty Return.	Machine Cutting.
1	Gray planer.	24 in.x 6 ft.	Cast iron.	.....	.24	.62	.50
2	"	"	" "	14.1	.20	.64	.54
3	"	"	Mach'y steel.	18.0	.17	.37	.95
4	"	"	" "	12.1	.33	.65	.92
5	"	"	" "	21.2	.33	.62	1.35
6	"	"	" "	.....	.23	.47	.94
7	"	"	Cast iron.	13.7	Average .64	.....	1.03
8	"	"	" "	21.7	" .64	.....	1.29
9	"	"	" "	24.7	.....	.....	1.58
10	Hendey shaper.	16 in.	" "	10.5	Average .153	.....	.44
11	"	"	" "	8.7	" .153	.....	.25
12	"	"	" "	13.5	" .153	.....	.77

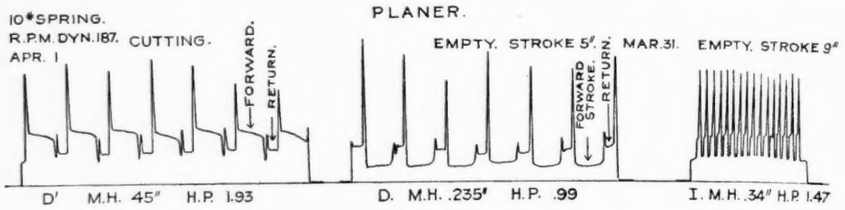


FIG. 1

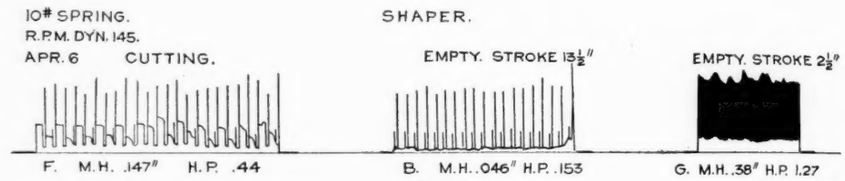


FIG. 2

stroke; i.e., the shorter the stroke the greater the power. The power used in cutting depends largely upon the condition of the tool. In our experiment with a dull tool the horse power of this same machine ran as high as 2.56.

Experiments 1 to 6, in Table II., were made with a Webber dynamometer. Those marked 7 to 9 were made with a Flather recording dynamometer, and in Fig. 1 are shown sample diagrams. The diagrams, as shown and figured in the cut, include the power required to run the countershaft. The diagrams show clearly the ratio of forward to return stroke, and the jumps in pressure due to reversal, a high jump at the end of the return and a lower jump at the end of the forward stroke.

The experiments on the Hendey shaper were also made with the Flather machine, and diagrams are shown in Fig. 2. The power required to run the shaper empty depends very much on the stroke.

As shown in Fig. 2. the horse power required to run the empty machine with a 2½-inch stroke, was 1.27. It may be noted in passing that this shaper can remove more metal per horse power than the much larger planer, the maximum record of the planer being about 26 lbs. per H.P. per hour, and of the shaper 35 lbs. per H.P. per hour. This shows one advantage of moving the tool rather than the work.

Engine Lathes.

TABLE III.

No.	Kind of Machine.	Size.	Material Cut.	Pounds Metal per Hour.	NET HORSE POWER. Empty.	Cutting. Min.	Max.
1	Putnam lathe.	16 in. x 8 ft.	Cast iron.	.....	.03	.22	.27
2	" "	" "	Mach'y steel.	.....	.04	.25	.30
3	Flather "	22 in. x 6 ft	" "	5.3	.09	.28	.44
4	" "	" "	Cast iron.	9.1	.07	.....	.26
5	" "	" "	" "	15.0	.07	.....	.47
6	" "	" "	" "	19.6	.07	.....	.81
7	" "	" "	" "	14.9	.07	.....	.62
8	" "	" "	Not cutting.	.....	.....	.07	.30
9	" "	" "	Cast iron.	20.6	.....	.....	.53
10	" "	" "	Tight center.	.....	.....	.25	.58
11	Putnam lathe.	16 in. x 8 ft.	Mach'y steel.	5.7	.08	.....	.54
12	" "	" "	" "	8.2	.08	.....	.64
13	" "	" "	" "	9.0	.08	.....	.71
14	" "	" "	Hot box.	.....	.....	.....	1.05

The horse power given in the tests shown in Table III. are the net powers consumed by the lathes, the friction of the countershafts being deducted.

Experiments numbered 1 to 5 were made with the Webber and the rest with the Flather machine, at the Case School. No. 8 shows the minimum and maximum power required to run the empty lathe, various speeds and combinations of gears having been tried. No. 10 shows one effect of screwing the foot spindle up against the work when the tool was not cutting. No. 14 shows the effect of a hot box on the main spindle.

Fig. 3 gives diagrams from these two lathes, illustrating the effect of dry bearings on the power consumed.

Miscellaneous Machines.

Several tests have been made by the writer on a Prentice upright drill of twenty-four inches swing. The power required to run the drill on ordinary work is very small, usually about one-tenth of a horse-power. The greatest power developed on any of these tests was 0.75 H. P., when the machine was drilling a 15-16 inch hole in machinery steel, at the full capacity of the drill.

Woodworking machinery generally consumes more power, on account of its greater speed. An ordinary 12-inch or 14-inch lathe, such as is used by pattern makers, will consume more power than an engine lathe of even greater size.

A band-saw, with 36-inch wheels, will consume from one-half to 1 H. P., according to the work.

A 12-inch buzz planer consumes from one-third to one-half H.P. when running light, and from this up to three H.P. when cutting.

Prof. Flather, in his treatise on Dynamometers, p. 154, gives a table showing the power required to drive lathes empty at various speeds, with and without back gears. In general, the power consumed is greater at the higher speeds, and without back gears. For lathes varying from 12 inches to 26 inches, the horse power varied from .035 to .455, when running empty.

As the results of his experiments, Prof. Flather recommends the following formulae for the horse power required to remove metal in a lathe, where W is the weight of metal removed, in pounds, per hour:

H.P. = .026 W for cast iron.
H.P. = .030 W for wrought iron.
H.P. = .044 W for steel.

This gives the net power required, over and above that consumed in running the lathe itself.

Table III. gives slightly different values of the constants in this formula:

H.P. = .035 W for cast iron.
H.P. = .067 W for machinery steel.

Three experiments with a Gray planer give:

H.P. = .032 W for cast iron, while three experiments with the Hendey shaper give:

H.P. = .030 W for cast iron.

To these powers in each case must be added that consumed in running the machine itself.

In the "American Machinist" for April 12, 1894, is given a table of horse powers for 56 different machines, both light and loaded. This table was compiled by Prof. Flather from various sources, and is too long for reproduction here. A few averages are given, calculated from his figures.

TABLE IV.

Kind of Machine.	Number of Machines Tested.	Sizes.	Total Horse Power.		
			Min.	Max.	Average.
Engine lathes	7	12 in. to 80 in.	.33	.91	.57
Shaping machines	5	4 in. to 29 in.	.16	1.14	.48
Drill presses	7	.....	.41	1.33	.84
Milling machines	4	.....	.18	.66	.35
Wood planer	6	13½ in. to 28 in.	3.03	6.91	4.50

In the same article Prof. Flather gives the following constants for the power required to remove metal with a milling machine:

H.P. = .14 W for cast iron.
H.P. = .10 W for bronze.
H.P. = .30 W. for tool steel.

Comparing these with similar formulas for lathes and planers, we find that the milling cutter is much less efficient than the diamond point as regards the power required.

Counters and Belting.

In determining the total power which will be required in a given shop, it is necessary to know approximately the proportion of power absorbed by the counters, belting and line shafts.

In a paper read several years ago before the Am. Soc. Mech. Eng.,* the writer showed that in six heavy machinery establishments in Cleveland, an average of 62 per cent. of the total power was consumed in this way, while in six light machinery establishments in the same city the loss averaged 55 per cent.

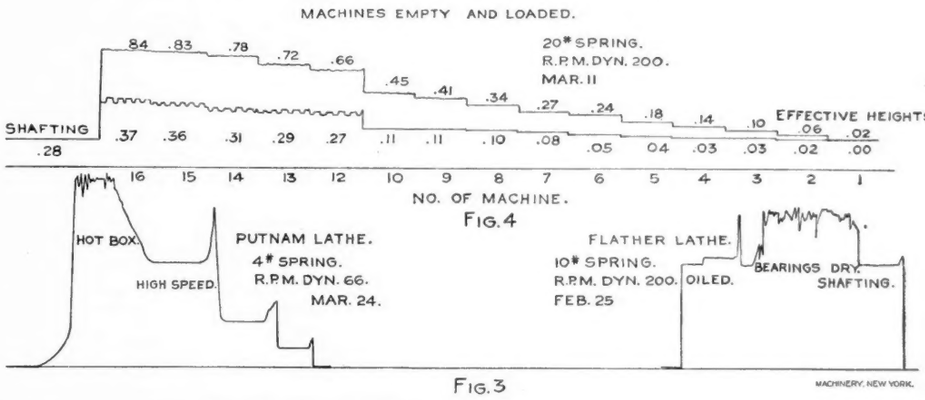


FIG. 3

MACHINERY, NEW YORK.

That these averages can be improved upon there is no doubt; whether they will be, is another matter.

Table V. shows an analysis of the power consumed in ten of these cases. The table is self-explanatory, but it may be said that the horse power per countershaft seems to be the most convenient factor, being quite uniform.

The general average, per counter, is about 0.6 H.P. for heavy work and 0.2 H.P. for light work.

TABLE V.

Nature of Work.	Friction Horse Power.						Useful Horse Power.	
	Per 100 feet of Shafting.	Per 100 lbs of Shafting.	Per 100 sq. ft of Shafting per Minute.	Per Bearing.	Per Counter.	Per Belt.	Per Machine.	Per Man.
Boiler shop	4.77	.205	.04	.550	.538	.477	.310	.877
Bridge work	3.28	.137	.04	.337	.606	.521	.164	.142
Heavy machinery	5.70	.233	.038	.581	.665	.453	.707	.160
Heavy machinery	8.55	.306	.06	.799	.600	.475	.627	.342
Average	5.57	.220	.044	.567	.602	.481	.452	.380
Light machinery	2.75	.276	.034	.204	.155	.095	.790	.099
Small tools	8.00	.400	.09	.689	.127	.119	.109	.152
Small tools	2.49	.233	.03	.240	.121	.113	.881	.227
Sewing machines	4.36	.430	.05	.397	.269	.208	.180	.204
Sewing machines	5.08	.134	.034	.406	.172	.154	.181	.093
Screw machines	6.33	.381	.05	.633	.291	.235	.296	.396
Average	4.83	.309	.048	.428	.189	.154	.406	.195

The next to the last column shows the average useful horse-power per machine in each shop; the variation here is considerable, as might be expected.

If we add the horse-power per counter, to the useful horse-power per machine in the two averages, we have a total of about one H.P. per machine for heavy work and about 0.6 H.P. per machine for light work.

These are, however, merely averages, and possess little practical value.

Table V. speaks for itself and one may choose from it whatever suits his particular case.

In experiments made last year at the machine shop of the Case School of Applied Science, using a Flather dynamometer to drive the line shaft, some interesting results were obtained. The shop contained nine engine lathes of different makes, ranging

* Trans. A. S. M. E., Vol. XVIII., p. 228.

from 12 to 22 inches swing, one planer, 24 inches x 24 inches x 6 feet; two shapers, of about 15 inches stroke; two upright drill presses, a No. 1 B. & S. milling machine, and several small tools.

The line shaft was of 1 15-16 inches turned iron, about 90 feet long, and running 200 revolutions per minute. There was the usual assortment of belts and counters.

When the shop was run at its full capacity, all the larger machines being in use, the distribution of the work was found to be as follows:

	H.P.	Per Cent.
Line shaft alone	0.84	8
Thirty belts and loose pulleys	1.73	17
Sixteen machines, empty	3.45	34
Cutting metal	4.25	41
Total	10.27	100

These figures are much better than would be shown by an ordinary run, as the machines were working above their usual rate.

Fig. 4 is a diagram from the dynamometer, showing the relative loads due to the shafting and the different machines. In the upper line we see the machines thrown on successively, beginning at the left with the lathes and ending with the shapers and planers, all cutting. The second line shows the same for the machines not cutting.

In using any of the figures given in this article, it must be remembered that circumstances alter cases. The power required to cut metal depends on the skill of the workman; the power used by the machine itself, its counters and the line shaft, depends on the care and skill used in their erection and maintenance; finally, the total power consumed by machine tools depends upon how hard they are crowded.

Any number of isolated examples such as are given in this article, can only help the manufacturer to judge for himself of the power required in any particular case.

* * *

Our valued contributor, Mr. A. H. Eldredge, who has been an instructor in mechanical engineering at Cornell University for several years, has accepted an important position as mechanical engineer of the Swift plant at St. Joseph, Mo. His removal from this section of the country will preclude the possibility of his continuing in charge of the "How and Why" department, but we trust that he will be able to write regularly for our columns.

* * *

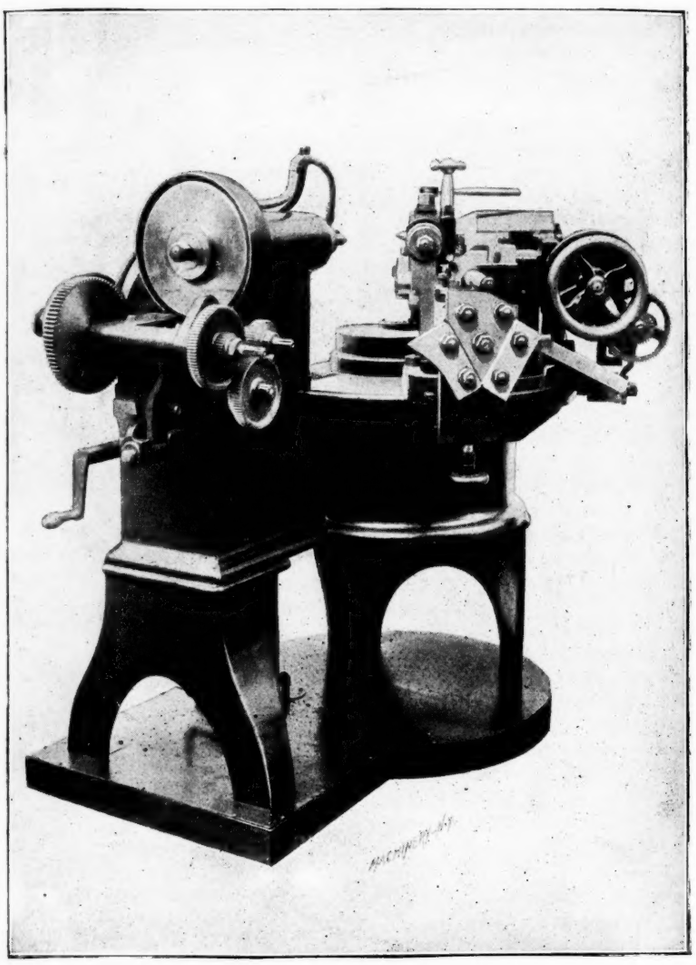
BEVEL GEAR PLANER.

It is undoubtedly a fact that where bevel gears are used on the better class of machinery they are usually inferior in construction to the other operating parts. Where we have accurately cut spur gears, ground bearings and scraped sliding surfaces, we find bevel gears, either as cast in the foundry or as cut with a rotary cutter on the milling machine. Large bevel gears, intended for important work, are quite frequently planed with accurately shaped teeth, but the smaller sizes are generally of the other kind.

A machine that should do much to bring about a different order of things has just been brought out by The Gleason Tool Co., Rochester, N. Y., and is illustrated herewith. It will cut gears up to 12 inches in diameter, and is therefore adapted to the usual run of small and medium size work. It is smaller than any machine heretofore made by this company.

Our readers are already familiar with the standard type of machine made by the Gleason Tool Co. The cutter is guided by a former and moves along lines radiating from the apex of the gear. The gear is mounted on a horizontal spindle and adjusted by moving the head along the frame until its apex coincides with the center of the machine. The slide on which the tool holder travels is pivoted at the above center so that it can be moved in line with the pitch line angle of the gear. The slide is also hinged at the same center so as to permit a vertical adjustment as it is fed over the former and thus the tool travels on the correct angle of the gear at every point of the tooth curve and the small end of the tooth is made proportional to the large end.

The new and smaller size machine has two important improvements which have not been previously applied. From the cut it can be seen that the roughing formers, the one for the upper side of teeth, and the one for the under side of teeth, are in a revolving holder so they can be brought into position without removing one to give place to another. This saves time in "manufacturing" work when there are several gears of the same size to be cut in succession, so that only one set of formers is in use for some time. And it has no disadvantage for jobbing work when the formers are changed for varying sizes of gears, because they are as readily fastened as in the ordinary form-holder. The other improvement is a sizing arrangement for getting the thickness of teeth, which does away with the use of caliper or gauges. The machine is automatic.



BEVEL GEAR PLANER FOR SMALL WORK.

VARNISHING A CYLINDER.

In a certain penal institution of New York State the convicts are required to run the engines and fire the boilers, and, in fact, perform all service that can be safely intrusted to them. Those to whom the more important positions are assigned are called "trustys," being men who have only a few months more to serve and whose records have been good. But the fact that they are "trustys" does not necessarily imply that they are always trustworthy in matters relating to steam engineering. A trusty, who had charge of a Corliss engine, sent in a requisition for a gallon of valve oil, but by some mistake a can of varnish was given him. Instead of returning it and getting the proper article the varnish was used, with results that will be left to the imagination to picture. The machinist who overhauled the engine did not have to draw on his imagination, however, as the job of getting the varnished interior into shape for the "trusty" safe-cracker engineer left but little time or disposition to imagine anything worse than what he saw.

PRACTICAL PROBLEMS.—5.

PROBLEMS 9 AND 10 WITH ANSWERS TO PROBLEMS 7 AND 8.

FRED E ROGERS.

The problems for this month are contributed by Milo, and are some of the snags met with in actual practice.

The interest taken in this department is very gratifying, and shows that our subscribers appreciate the opportunity to do some thinking for themselves. It cannot be denied that drill of this kind is of the greatest value, and we shall esteem it as a special favor if those questions which have proved puzzlers in actual shop experience, are sent in for solution. Just give the idea, and we will do the rest.

The replies to problems 5 and 6, published in the February MACHINERY, are probably sufficient for a clear understanding of the solution, and we shall be obliged to give the names only of those who sent correct solutions later.

Ernest L. Darling, Providence, R. I., No. 5.
"W. L. G.," Nos. 5 and 6.
James Stillman, Hamilton, O., No. 5.
J. Rhyner, Spreckels, Cal., Nos. 5 and 6.
C. Albert Wettengel, Pittsburg, Kan., Nos. 5 and 6.
E. C. Slater, Erie, Pa., No. 5.
C. C. Sampson, Ottumwa, Ia., Nos. 5 and 6.

By a graphic method, O. Benefiel, of Anderson, Ind., finds the stroke to be 9⅞, and the displacement of the crosshead as practically ⅜ in. A "Kid" also sends in correct solution to No. 6.

9.—To find the Ratio of Cone Pulleys.

In the combination of movements shown by Fig. 1, it is desired to know what ratio should exist between the diameter of the steps X and Y, of the cones B and C, so that with the belt in position shown, one rotation of A shall move the rack D down 1-100 of an inch.

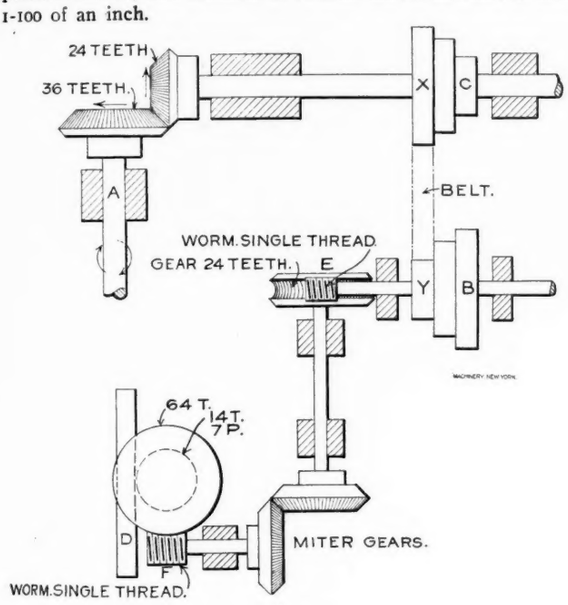


FIG. 1.

Should the worms E and F be right or left hand, with the shaft A turning in the direction of the arrow?

10.—An Epicyclic Chain Hoist.

In Fig. 2 the readers of MACHINERY will find an excellent example in epicyclic trains, which often are very confusing to understand.

As will be seen D forms a stationary internal gear, in which mesh the three pinions C C_1 and C_2.

These are carried on the frame E, and each have mounted on the same shaft the gears B B_1 and B_2, which all engage with the pinion A.

What number of times will S have to be turned to give one rotation of M?

Answers to Problems 7 and 8.

Quite a number of replies have been received to the February problems, but none of them so far have contained a correct solution to No. 7. All those who solved it left out an element in their calculations which is of vital importance; in fact, it was just the point sought. The following solution, by Mr. James Dangerfield, Elgin, Ill., is given as an example, which is correct, up to the matter of pitch.

Mr. Dangerfield refers to the sketch given with No. 7, and says:

"As the centers of D, B and E are equidistant from the inside periphery of A, they are points in a circle concentric with A.

"An angle in a semi-circle, whose opposite side coincides with the diameter, is a right angle; therefore, D, B, E, is a right-angled triangle, whose hypothenuse is 6¼in. and altitude 3¾ in.

$$\sqrt{6\tfrac{1}{4}\text{ in.}^2 - 3\tfrac{3}{4}\text{ in.}^2} = 5\text{ in.}$$

distance between centers of D and B.

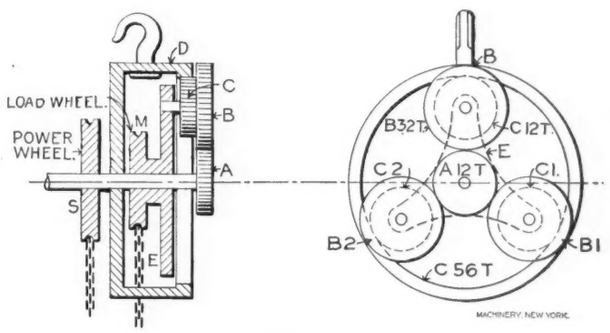


FIG. 2.

"As diameter C + semi-diameters D and B equals 5 in., the diameter of each wheel, D, C, B and E, is 2½ in.

6¼ in. + 2½ in. = 8¾ in. = inside diameter of A.

"The ratio of outside diameter of D to inside diameter of A is 2½ to 8¾, or as 1 to 3½.

"Toothed wheels can be used of same proportions and center distances as the friction wheels. Any number of teeth can be used that are in the proportion of 1 to 3½. Let us choose 20 teeth for the small wheels and 70 for inside of rim A. The pitch for these numbers will be $\frac{2.5 \times 3,1416}{20} = .3927$ inches."

Now, if all the wheels be free to adjust themselves to whatever position required, it is clear that any pitch that would divide the pitch circles of A and the small gears without a fractional remainder would answer the conditions. But these conditions do not prevail, as the train D, C and B are in mesh, and therefore locate certain points that must be considered before the pitch can be determined.

Referring to Fig. 3, we will suppose that the small gears all have a number of teeth exactly divisible by 4, and that the

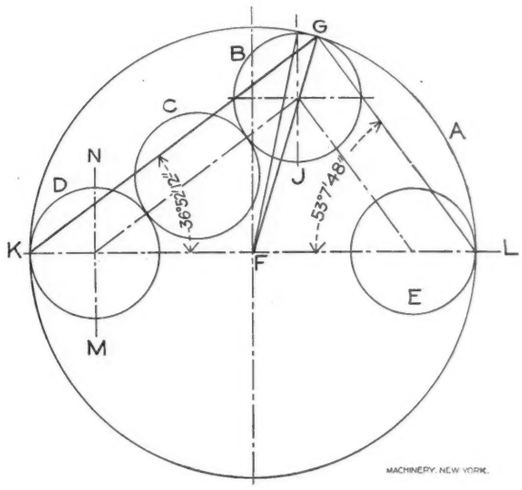


FIG. 3.

line K L passes through the center of a tooth space in A at K. This being so, the line K L will pass through the center of a tooth in the gear D, and a vertical line through the center of D will also pass through the center of a tooth at the top and bottom. Now, it is well known that with three gears in train of equal pitch circles, the movements of the first and third are the same so

the vertical lines through D and B, as shown in the sketch, will be always parallel. This being so, a little reflection will show that the center of a tooth under the conditions named will come at I. Therefore, a tooth space in A must also come at this same point.

Now, as none of the correspondents considered this point in their solutions, we cannot allow that they are correct until they can prove that these conditions will be satisfied. It is somewhat doubtful if any practical pitch can be found that will exactly satisfy the requirements, but the problem will be allowed to stand another month to give all a chance to worry their brains over the matter, and possibly find an approximate pitch that will fulfill any reasonable requirements. A number of others gave practically the same results, but we will give them a chance to try again.

Mr. Dangerfield also sends the following excellent solution to problem 8:

While carriage moves 9 in. to left, rack K moves downward 5.4978 in., which rotates pinion R $\frac{5.4978}{1.75 \times 3.1416} = 1$ revolution, which rotates bevel J 1 revolution, which rotates bevel pinion I and nut $\frac{64}{16} = 4$ revolutions, in direction carrying carriage to left.

The pitch of lead screw being ¼ in., the movement of carriage due to 4 revolutions of nut is ¼ in. $\times$ 4 = 1 in.

Of the 9 in. carriage movement the amount due to revolution of lead screw is 9 in. — 1 in. = 8 in., for which is required $8 \times 4 = 32$ revolutions of lead screw, and $\frac{48 \times 32}{24} = 64$ revolutions of spindle; $\frac{64}{9} = 7$ 1-9, or 7.11 threads per inch cut.

Mr. W. E. Hunter, Cincinnati, Ohio, gives a very concise solution to No. 8, and also gives the inclination of the bar to cut the screw of the chuck problem. H says:

In problem 8, suppose spindle to be rotated until carriage moves exactly nine inches, then will

$$\frac{\frac{5.4978}{3.1416}}{8} \times 14 \times \frac{64}{16} \times \frac{1}{4} = 1$$

be the amount of this movement, for which the mechanism is responsible. This leaves 8 in., the amount due to rotation of screw, and requires 64 turns of spindle, thus cutting $\frac{64}{9}$ or 7 1-9 threads per inch. Calling 5.4978 in. the vertical component of the slide, the horizontal component should be $\frac{8}{8 - 7.071} = 8.6114$ inches to cut 7.071 threads per inch by the same arrangement of gears."

Mr. C. Albert Wettengel, Pittsburg, Kan., suggests that problem 8 be varied by giving an incommensurable thread, to be cut to find the inclination of the bar. This was implied in the problem, although the solution was not asked for. Mr. Hunter, however, gave the solution in his answer. Mr. Wettengel says:

The gear R, which has 14 teeth, 8 pitch, giving 1¾ in. pitch diameter and 5.4978 in. circumference of pitch circle, is just the amount bar O is inclined in 9 in., so that if the carriage is moved 9 in. the rack K will move just enough to give R, and with it J, one turn. As J has 64 teeth and I has 16, the nut I will make 4 turns during the 9 in. travel of carriage. With 24 on stud, 48 on screw and 4 pitch screw, the lathe will ordinarily cut 8 pitch, and the carriage will move to the left. This will move K downward and through R and J rotate I opposite to the screw, thus advancing the carriage faster than the screw alone, by 4 turns of the nut, which equals 1 in. in 9 in. Hence, only 8 in. in 9 in. of movement are due to the rotation of the screw, and this corresponds to 32 turns of the screw, or 64 turns of the spindle. Since the screw that would be cut would have 64 threads in 9 in., the pitch equals $\frac{64}{9} = 7$ 1-9.

ABOUT PROBLEM 6.

Editor MACHINERY:

Will you kindly, through the columns of MACHINERY, give me a little light on problem 6 and its solution by Mr. Mason?

This is the way I figured it out: If 6 ft. are unwound from a 2-ft. pulley, the system will make one turn nearly, and in rolling one turn on the floor, the system will move a distance in proportion to the diameters, or 9 ft. to the left.

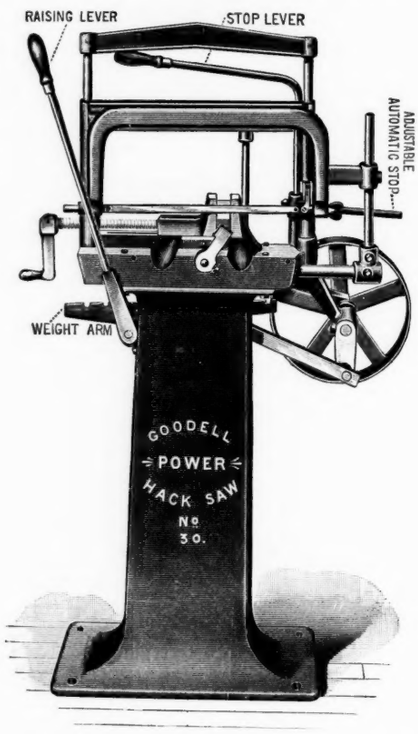
I cannot see how the system can possibly roll to the right by pulling the cord to the right, which comes from the bottom of the 2-ft. pulley, as shown in the sketch. F. B. H.

[The trouble with our correspondent is that which most every one meets when this question is first proposed. In thinking of a wheel and axle, the point of support, or fulcrum, is naturally thought to be that of the axle itself, but in this case the point of support is at the rim of the pulley, where it rests on the shop floor. If F. H. B. will cover the sketch in the January MACHINERY, so that all that is shown is the cord and the arm of the pulley, from the floor up to the hub, he will have no difficulty in seeing why the pulley rolls to the right, and he will then be in a position to understand Mr. Mason's solution.]

* * *

POWER HACK SAW.

The Goodell Brothers Co., of Greenfield, Mass., have just brought out and are putting on the market their new power hack saw, No. 30, an illustration of which is shown herewith. The manufacturers state that they have spent a long time experimenting upon machines of this character, in order that this one might embody every mechanical idea that experience and study could devise, which would enhance its working value. It will be noted that the machine is very compact and economizes floor space, and also that its various working parts, and the operating



levers, are convenient to the hand of the operator when he stands in front of the machine. One of the features is an automatic stop, which can be set to stop the saw at any desired depth in the work, or after the same has been completely cut off. This mechanism is instantaneous in its action. The starting or stopping lever is connected directly with a clutch on the main driving pulley, which either locks or disengages the crank shaft of the machine. The vise is square with the saw, the bed of it extending beyond the jaws to avoid the possibility of sawing into the end of the work after it has been cut off. The frame which carries the saw runs in a guide at its back, which, in turn, slides up and down on a perpendicular guide rod, and the traveling motion is conveyed with a horizontal guide rod, which runs parallel to the blade of the saw. Each machine is fitted and furnished with one 12-inch Goodell Hack Saw Blade, and is capable of sawing work 4 in. by 4 in.

The dimensions of the machine are as follows: Extreme height, 43 in.; height to the top of vise, 28 in.; net weight, 150 pounds.

THE CORLISS ENGINE.—4.

CORLISS GOVERNORS—FLY-WHEEL AND OTHER ACCIDENTS.

A. H. ELDREDGE.

By referring to Fig. 11, Art. III, can be seen the usual type of a Corliss governor. The operation of the governor and of the safety stop was explained in Art. III. The principle of the safety stop, illustrated by some of the ordinary forms, was also explained. It was not the intention of the writer to discuss in detail the many types of safety stop that have been placed upon the market during the past few years.

From Fig. 11 it can be seen that the governor is driven by a belt from the main shaft. This practice was handed down by George H. Corliss and has been honestly followed by Corliss engine builders to the present day.

Let us look somewhat into the details of this belt problem. When the belt is laced, which is usually the case, every time the lacing passes over either pulley it causes the governor to jump, thus affecting more or less the steady regulation of the engine. Sometimes an endless belt is used, which is better, though the engineer in charge is apt to let the engine run with a slack belt, since it is more trouble to make a splice than to lace a belt, and where the engine is only shut down for a few hours out of the twenty-four, the temptations are to let the repairs go. Still another fault, and one of the strongest objections to the governor belt, is that oil from the main bearing, the eccentric and the governor will, sooner or later, saturate the belt; the result is that, even if the belt be fairly tight, more or less slipping will occur, and especially with the heavy governors of large engines. What is the result? Simply that when the load is thrown off the engine, the governor, instead of raising to its proper height for the right cut-off, will fall below that height and will permit a cut-off greater than is necessary for the work being done, which ends in a runaway engine, with the usual result of destroyed property and often the loss of life. Instances are recalled where engineers have caught their engine in time to save it, and after having tightened their governor belt, the engine has run along all right. (See "Power," August, 1898 nd November, 1898.)

Another threatening danger lies in the fact that when the governor is in a position of early cut-off the dash pots act more sluggishly than with the later cut-offs; in consequence the steam port will remain open for a considerable period of time after the knock-off clips operate, in which case, if the governor cannot raise to its highest position and cut off steam entirely, a runaway engine will follow in the natural order of events. Still another cause of accidents is the working out of governor pins or keys, allowing the governor to stop working, and in some cases they work out in such places that, even if there be a safety stop, it cannot act; the result being, as usual, disastrous. (See "Power," August, 1894 and July, 1897.)

Having shown that the governor is not to be relied upon, as it is usually constructed, let us consider its qualities from still another standpoint, and that is its efficiency of regulation. How close will the Porter type of governor, as illustrated in Fig. 11, Art. III, govern? Having looked into this question carefully, the writer feels warranted in the statement that none of the Corliss engine builders would guarantee a regulation from light to heavy loads closer than 3 per cent., and he will go still further and state that many of them who may claim as good as 3 per cent. cannot govern better than 5 per cent., and that, too, with a skilled engineer to handle the engine, and with the help of an extra heavy fly-wheel.

Being interested in this question, the writer has tested, with the most delicate apparatus, the governing qualities of engines built by some of the leading Corliss builders, and has proven to his own satisfaction the truth of the above statement. As an offset to this statement the question may be asked, How close do the high-speed automatic engines govern? And in answer it can be stated that many high-speed builders will guarantee a regulation within 1½ per cent., while some builders will guarantee a regulation to 1 per cent. or better. Again, their governors have positive connections from the main shaft to the valve, and thus reduce the liability of a runaway engine. As a result of this construction the fly-wheel accidents, or runaway engines of the shaft governor type of engine, are comparatively few, and where such accidents do occur they can almost always be attributed, not to faulty design, but to defective material or workmanship.

FLY-WHEEL ACCIDENTS ON CORLISS ENGINES.

Date of Accident	Place.	Size of Engine.	Fly-wheel. Diam.	Fly-wheel. Face.	Speeed at Time of Accident.	Cause of Accident.
*Mch., '92	Lowell, Mass.	20 x 36 x 48	20	49	Raced	Unknown.
*Oct., '93	Brooklyn, N. Y.	20 x 36 x 48	20	52	Raced	"
*Dec., '94	Des Moines, Iowa.	30 x 60	20	50	Normal	"
*Apr., '94	Pittsburg, Pa.	22 x 42	20	32	Raced	Broken driven pulley.
*Aug., '94	Nashua, N. H.	30 x 60	30	60	Raced	Pin dropped out of governor.
July, '94	Manville, R. I.	26 x 48	20	25	?	Poor fly-wheel.
Juiy, '94	Manville, R. I.	18 x 32 x 48	20	25	?	" "
*Nov., '95	Hoboken, N. J.	500 H. P.	17½	52	Raced	Governor belt gave way.
July, '96	American Wire Works.	24 x 60	..	..	.....	....
*Nov., '97	Providence, R. I.	18 x 42	13	20	Raced	Governor belt slack and oily.
*July, '97	Tacoma, Wash.	30 x 44 x 48	25	72	.....	Unknown.
*May, '98	Berlin, N. H.	18 x 42	15	24	Raced	Governor out of order.
June, '98	New Bedford, Mass.	20 x 42	17	37	.....	No information was obtainable.

* Illustrated articles.

Turn now to the table of Corliss Engine Acci ents. The table was compiled from accidents recorded in "Power' during the past few years. Accidents that could be attributed to a broken shaft or similar defects were purposely omitted. In looking over the list of accidents it will be found that most of them are from illustrated articles, while many form the leading article in the issues in which they appear. No such list of accidents can be found during the same time from any other class of engine. Another noticeable thing in looking up the list is that in most cases the statement is made that the engine was running above its normal speed at the time of the accident. The accident is not always attributed to the governor. Sometimes it is stated the generator was sparking badly, or a heavy load was suddenly thrown off or on the engine, but the fact still remains that at the time of the accident the engine was racing. Quite a number of deaths or of serious accidents, besides a large property loss, was the result of these accidents.

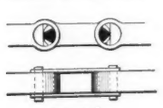


Fig. 16.

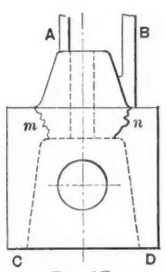


Fig. 17.

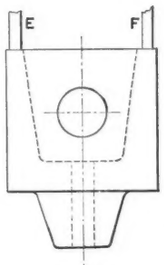


Fig. 18.

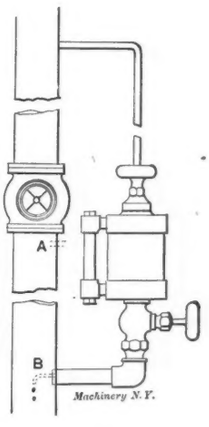


Fig. 19.

There is no doubt about the high efficiency of the Corliss engine as to the amount of steam used per I.H.P. per hour. Its staying power and durability are unquestioned. The question now presents itself; what can be done to secure the efficiency and reliability for the Corliss governor that has been attained in high speed work? The writer would offer a few suggestions to the young engineer, as follows:

The purchaser could be brought to insist on a modified governor construction, or, better still, where a consulting engineer is employed, let him specify a rigid governor connection, and that the governor regulates to 1½ per cent. or better. Then, after the engine is installed, make the company live up to its guarantee.

One improvement that could be applied to any engine now in operation would be the employment of a chain drive in place of the present belt. A good bicycle chain will stand a load of 900 pounds or over before breaking. The Morse chain, Fig. 16, works on the knife edge principle, and will run almost indefi-

nitely without perceptible wear, and requires little attention, so far as oiling is concerned. Any of these chains are far stronger than the belt usually employed, though, to make surety doubly sure, two chains could be use . The cost of chains and gears would exceed but little the cost of belt and pulleys. Another construction would be a shaft and bevel gear, but this could not so easily replace the belts where in use. All pins in the governor should be secured with a split cotter or other safety device.

For engines yet to be built the writer would suggest the use of a light sensitive shaft governor, first, because it would offer greater safety with its fixed connections; second, it would be far more sensitive; third, the probable cost would be less than of the present construction; fourth, with but one wrist plate the range of cut-off could extend from zero, or no cut-off, to the full stroke of the engine.

Such a governor need not have the heavy construction of similar governors on high-speed engines, since it does not have to handle the valves of the engines, but simply moves the knock-off levers back and forth, as shown in Fig. 11, Art. III. At the same time it could be mounted directly in the fly-wheel of the engine where desirable.

CROSS-HEAD ACCIDENTS.

While we are at it, let us consider one or two other causes of accidents. There is one cause equally applicable to all types of engines using cast-iron cross-heads, and it is a cause that has resulted in many accidents all over the country.

In Fig. 17 is shown the usual position of the cross-head for casting. The metal is poured at A, with a riser at B to carry off the dirt and sand rising from the mould. The result is that the best of the metal is cast at the end C D, while at m, n the lightest, most porous metal, will be found, and almost without exception the metal at n, when the riser B is knocked off, will be found porous, as can be easily detected, even after the cross-head is finished. This weakens the cross-head greatly, so that a little water in the cylinder, or a heavy load thrown on suddenly, will cause the neck of the cross-head to pull out along the lines m n, as shown in Fig. 17. If now the cross-head were cast in the position shown in Fig. 18, the best metal would be cast under pressure where it is most needed, leaving the porous metal at E or F, where it would in no way affect the strength or wearing qualities of the cross-head. The neck of the cross-head would also be susceptible of a much finer finish.

One other point and this chapter of criticism will be over. Many lubricators are attached to the steam pipe, as shown in Fig. 19, with one connection on one side of the throttle valve and the other connection on the other side. Then when the engineer stops the engine, if he should neglect first to shut off the lubricator it will very quickly empty itself of oil, on account of the great pressure of steam above the valve. Make both connections on the same side of the throttle, as at A and B, even if it be necessary to put a loop in the lubricator pipe. Again, too many lubricators are connected to the steam pipe without carrying the feed to the center of the pipe, as shown at B, Fig. 19. Where the lubricator pipe is simply tapped into the side of the steam pipe the oil flows down the side of the pipe, and most of it will be carried by the rush of steam to one set of valves; the chances are that the other set of valves will not be properly lubricated, and that sooner or later they will get to cutting. When this happens the hook will only pick up the dash pot plunger part way, and then, due to the great friction of the valve, will slip off the hook pin. The friction of the valve will also hold up the dash pot plunger, and the valve will remain open until the hook drives down the plunger on its return motion. The engineer will frequently jump for the dash pot at such times, while the trouble usually lies with the lubrication of the valve. A pint of oil and a pump are the quickest remedies, though the valve should be taken out and scraped, if necessary, when the engine is shut down.

* * *

The German authorities have decided upon a style of bicycle tire made at Dresden, for use in the army in place of the pneumatic variety. This tire is said to consist of an ordinary outer shoe which encloses a core whose lower half consists of spongy, resilient rubber, while the half next the rim is made of solid segments of cork, which are severed transversely at intervals and thus act as buffers to that part of the tire next the ground.

ROPES FOR POWER TRANSMISSION.

THE DIFFERENT MATERIALS USED—THREE VS. FOUR STRANDS—A NEW FORM OF SQUARE ROPE.

M. E.

That the degree of success achieved by any modern installation of rope driving plant depends to a very large extent upon the character of the driving rope adopted, few will dispute. As to the precise requirements to be met, and the best construction for meeting them, there is, however, not quite so general an agreement of opinion. The relative merits of three or four-strand ropes, of coton and manila as a material—and if the former, whether Egyptian or American is to be preferred—are all questions upon which a deal has been said at various times, but upon which opinion is apparently still as divided as ever. Nor does it appear probable that practice will become more uniform in the future, since the advocates of the four-strand rope are as fully convinced of the advantages of a large sectional area and a construction closely approximating to a circle, as the three-strand partisans are of the benefits of a simpler method of manufacture, especialy in splicing. As to the rival claims of cotton and manila, we find the former material coming more into favor on this side of the Atlantic for the larger sizes and powers, while in Europe, and even in England, manila is being quite extensively used, more particularly for the smaller diameters and lighter loads.

The three and four-strand ropes had never much to fear, in point of popularity, from the more complicated constructions introduced during the early days of rope driving in England. There are, however, still to be found those who pin their faith to the seven-strand rope, notwithstanding its complex construction and the consequent difficulty of neatly splicing it. There is, of course, something to be said in its favor, inasmuch as the separate strands composing it offer less resistance to bending when passing over pulleys, while, perhaps, some little advantage is to be obtained in the way of increased surface contact with the sides of the wheel groove. There is still a fair amount of this rope in use in the cotton spinning districts of Lancashire, but it is gradually being displaced by the simpler and less costly ropes of ordinary construction.

Much the same may be said in regard to the plan, at one time often adopted, of covering the rope with a wrapping of cord of about one-quarter inch diameter. This was wound tightly around the rope, with the object of securing a better grip of the pulley, but as this cover-cord, while increasing the weight of the rope, added nothing to its strength, and often caused trouble by unwrapping, it is not difficult to account for its disappearance.

Proposals to use fibers other than cotton and hemp come round with persistent regularity, and a few years ago the advantages of "ramie," or "China grass," were strenuously urged by those interested in exploiting the so-called "new" fiber. As a matter of actual fact, however, driving ropes of ramie were tried a quarter of a century ago, when it was found that the material, although excedingly strong, was deficient in flexibility, and rapidly gave out if used on pulleys of ordinary dimensions.

Those who hold fast to the theory that "there is nothing like leather" came early to the assistance of the users of rope for power transmission, and the plaited throng rope of raw hide or leather was one of the first types employed. It possessed the important features of strength and flexibility, but repeated failures, owing to the untwisting of the strands, soon led to the abandonment of this form of flexible transmitter. During recent years, however, ropes of twisted raw hides have again been employed, but only to a limited extent, and under such peculiar circumstances as would warrant the greatly increased outlay which the use of such ropes entails.

Square ropes built up by cementing and riveting together narrow strips of leather are used occasionally, and are especially serviceable in cases where the pulley width is limited, as a larger amount of power can be transmitted within a given width than is possible with fibrous ropes. Thus, a 2-inch square leather rope, running at 4,500 feet per minute, can be safely trusted to transmit 100 H.P. in ordinary work, while in some instances much larger powers have been transmitted with ropes of this size, but, of course, with a corresponding reduction of their life.

One of the principal objections which have been urged against square ropes is their large resistance to bending. So far, how-

ever, as a comparison of actual sections will enable this point to be investigated, the advantage is on the side of the square rope, as contrasted with a round rope of equal section. Thus, taking for example, a 2-inch square rope, and comparing it with a round rope of equal section, and which would be of 2¼ inches diameter, we find that the resistance to bending is as 0.944 to 1.120; or, in other words, the round rope offers about 18.6 per cent. greater resistance than a square one of the same material.

From this comparison it might be inferred that the objection to the square rope on the score of increased resistance to bending is not a valid one. The fact must be borne in mind, however, that the cross section of, say, a four-strand rope—assumed to be circular in the foregoing—really consists of four smaller circular sections of the separate strands composing the rope, and which strands are capable of a slight self-adjusting movement among themselves, which, undoubtedly greatly reduces the resistance to bending. This latter evidently resolves itself into (a) the resistance to bending of the several separate strands, and (b) the resistance to the movement of the strands among themselves. With well-made ropes, laid in tallow and plumbago, it is not likely that the last-named element of resistanec will be large, so that in general the assumption that the round rope offers less resistance to bending than a square one of equal section is probably warranted, although the difference is not by any means as great as is generally assumed.

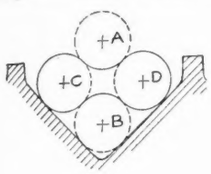


FIG.1

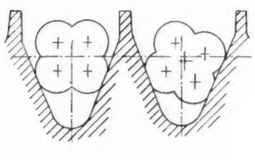


FIG.2 FIG.3

Attempts have been made to construct driving ropes of such a form as would combine the advantageous features of both square and round sections. One result is the so-called "square" hemp rope now being used to some limited extent in Germany and Switzerland. The special machinery which has been devised for the purpose of plaiting this rope was fully described recently in the "Zeitschrift des Vereines Deutsche Ingenieure." Eight strands are used in the formation of this rope, these being so plaited together that they are divided into two groups, each of four strands, one group having a right hand, and the other a left-hand twist. Each of these groups of strands are capable of moving independently of the other, so that when the rope is laid in a right-angled groove, as in Fig. 1, the group of strands, C and D, flatten and adhere to the sides of the groove, while the others, in groups A and B, will readily accommodate themselves to the curvature of the pulley without greatly affecting the adhesion of the acting sides of the rope.

There is no doubt that a very flexible rope is the outcome of this combination of dual sets of strands, while the resulting section much more nearly conforms to the shape of the pulley groove than is the case with any kind of round rope. Moreover, the square rope possesses another important feature, in so far as it entirely prevents axial rotation. It is well-known that with the ordinary form of rope, there is a marked tendency for the ropes to revolve while running, although the behavior of a set of exactly similar ropes in this respect is often very erratic. It is, however, generally admitted that axial rotation greatly increases the surface wear of the rope and lessens its life to a very marked extent. One prominent maker of driving ropes claims that the durability of a cotton rope is reduced by one-third if it is permitted to rotate, and although the writer is not prepared to altogether endorse this view, he is convinced from long observation that a turning rope has a materially shorter life than one which does not so turn.

Other advantages claimed for the square rope are: The greater ease with which splicing is effected, and a lesser tendency to stretch than round rope. Although the natural groove angle for square driving rope is 90 degrees, it does not appear from the published accounts of the new rope that such an obtuse angle as this has yet been adopted. There is a manifest disinclination to use a more open groove than 60 degrees, having in view the diminution in the grip which results from the use of the more obtuse angles, and in this connection it would seem that some modification in the shape of the new rope will be necessary, in order to reconcile the conflicting factors which evidently here exist. To place a square rope in a groove of 45 degrees, as is being done, is to court trouble on the score of differential driving, for it is readily apparent that while it is possible for some of the ropes to flatten at the sides, as in Fig. 2, others will take up the position shown in Fig. 3. It will be seen that in the latter case the center of the rope sinks lower into the groove, and as a consequence the lineal speed of this rope is less than that of one which lies symmetrically in its groove. The result of this differential driving effort is, the stoppage of some of the ropes, with a consequent increase of wear and more irregular driving.

Prof. Keller, of Karlsruhe, has given some attention to the subject of square driving ropes, and in the German publication above referred to he quotes an instance of a large pulley, carrying twelve ropes (the groove angle being 45 degrees), one of which he observed to be constantly changing its position, turning first one flat side and then the other, to the corresponding sides of the groove. The other ropes ran quietly in a half slanting position in the grooves. In the same works, another pulley, also having 45 degrees grooves and carrying twelve ropes, was newly set to work, and in this case nearly all the ropes jumped continually from side to side while working. It is evident from these observations that the square rope, when new, does not take up a stable position in the groove, but that as it becomes more supple in working it conforms more closely to the shape of the groove, the section becoming, in fact, more lozenge-shaped than square. This suggests that the construction of the rope might be so modified as to give it this form initially, failing which, an approximation of the desired contour might conceivably be obtained by passing the rope between a pair of rollers.

* * *

FAMILIAR SUBJECTS IN MECHANICS.—1.

STEP OR CONE PULLEYS.

SAMUEL WEBBER.

Among the questions continually arising in a shop, often explained, and yet always requiring fresh explanation, as a new set of young men come on the floor, is the proper proportion of a set of step (commonly called cone) pulleys, which will give a great variation in speeds, with the same driving belt, and on which the same belt will always fit with a uniform tension.

It is a very simple thing to do, with the help of a little patience and a fair knowledge of arithmetic, and although it calls for the use of "squares" and "square roots," they can almost always be found sufficiently close in any engineer's pocket book.

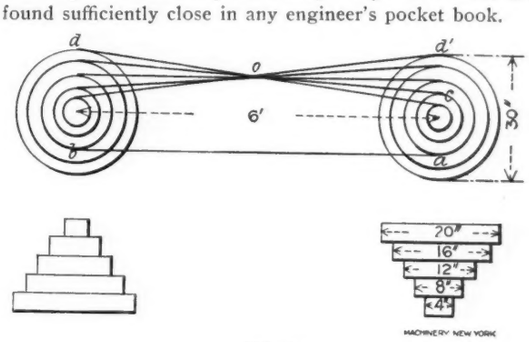


FIG. 1.

A look at the accompanying illustration will explain the matter at once. The length of the belt required is twice the distance between the centers of the shafts, and one-half the circumference of each of the pulleys, the driver and driven, or if the pulleys are of the same size, the whole circumference of one pulley. Thus, in the cut as shown, the distance between the shafts is supposed to be 6 feet, and the center pulley of each cone 12 inches diameter. Where there are a pair of even pulleys in the cones, they are used to determine the necessary length of belt, which in this case would be twice 6 feet, or 144 inches, added to the circumference of a 12-inch pulley, or 37.6991 inches. We may call it 37 7-10 inches safely, making the total length of belt 181 7-10 inches, and this must fit all the steps in the cone.

By looking at the cut it will be seen at once that the distance from c to d, or from the centers of the extreme pulleys, is longer than the distance from a to b, or the center line of the

two central pulleys, and is the hypothenuse of a right angled triangle, of which the distance between centers, a — b, is the perpendicular, and the difference in the semi-diameters, or radii, of the pulleys, c — d', is the base.

Now, the length of this hypothenuse, multiplied by 2, must be substracted from the total length of belt already determined, and the remainder divided proportionately between the semi-circumferences of the pulleys.

If we were to set out to get the five speeds, of equal velocity, 2 to 1, 3 to 1, 4 to 1, and 5 to 1, we should naturally proportion the pulleys as follows: If the belt would fit them, viz., 12 to 12 inches, 16 to 8 inches, 18 to 6 inches, 19.2 to 4.8 inches, 20 to 4 inches, which added together, gives a sum of 24 inches diameter for each pair of pulleys, but as the distance between the circumferences lengthens at each step, the diameter of the pulleys must be slightly reduced to meet it, and we will now show how this is done, referring simply to the tables of squares, and roots in Trautwine's Pocket Book. Taking the speed of 2 to 1, the difference in diameter is 8 inches, and that of the radii 4 inches. The square of 72 inches, the distance between centers, is 5,184 inches; to this add 16, the square of 4, and we get 5,200 inches. The square root of 5,200 is 72.11, and twice that is 144.22, which subtracted from the total length of belt as found, 181.7, leaves 37.48 inches for the semi-circumference of the two pulleys, instead of 37.7 inches, and this must be divided so as to give two-thirds to one-pulley and one-third to the other. It is not a very great reduction, but it is enough to make a belt slip, if stretched to it, when it goes back again.

Let us carry out our calculations. One-third of 37.48 is 12.49, and two-thirds is 24.98. Now to get the diameters these must

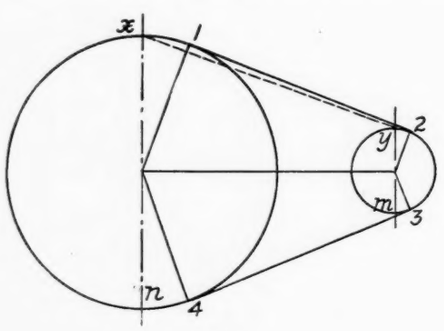


FIG 2.

be divided by 1.5708. We will omit the "08" and divide by 1.57, which gives for the large pulley a diameter of 15.917 inches instead of 16, and the small one of 7.958 instead of 8 inches. If we take the higher speed of 5 to 1, the difference will show more plainly. Here the pulleys will be 20 inches to 4 inches, and the difference of radii 8 inches. Add the square of 8, to 5,184, gives 5,248. The square root of 5,250, the nearest number in the table is 72.46; twice this, 144.92, which, taken as before, from 187.7, leaves 36.78 inches, to be divided between the two pulleys, five-sixths to one and one-sixth to the other, or 6.13 inches and 30.68 inches, respectively. These divided by 1.57 give 3.90 and 19.52 inches diameter for the two pulleys, or a reduction of half an inch in the diameter of the larger pulley. This would be one-quarter inch less radius, and were we calculating for a steel band, might require a second and revised calculation, but the elasticity of a leather belt may be relied upon to allow us to ignore this difference.

The illustration shows a pair of reversed cones, which would give speeds of 5 to 1, 2 to 1, 1 to 1, 1 to 2 and 1 to 5, respectively, and is supposed to have the even center pulleys of 12 inches diameter each and 6 feet apart. Now, it will be noticed that all the belts cross each other in the point O, half way their length, and to save the squares and roots of large numbers, we may calculate the hypothenuse of 3 feet, or 36 inches, perpendicular, instead of 72 inches, and multiply the result by 4, instead of 2, for belt lengths between centers. I may also note here, that for "cross belts" no calculation or allowance is necessary, one difference in the radius offsets the other, and the belt will always fit.

I find in an old memorandum book a calculation I made many years since of the diameters of a set of pulleys to give speeds from equal to 10 to 1, based on a pair of ten-inch pulleys, for equal speed, and they run as follows: Equal, 10 to 10 inches; 2 to 1, 13.33 to 6.67 inches; 3 to 1, 15 to 5 inches; 4 to 1, 16 to 4 inches; 5 to 1, 16.67 to 3.33 inches; 6 to 1, 17.142 to 2.857 inches; 7 to 1, 17.50 to 2.50 inches; 8 to 1, 17.777 to 2.222 inches; 9 to 1, 18 to 2 inches; 10 to 1, 18.18 to 1.82 inches. It will be seen that a line drawn through all these points, if laid out on a plan, would describe a parabolic curve, and by use of a calculation involving the higher mathematics, such a curve can be ascertained and is used in the construction of certain cones proper, employed in cotton spinning machinery, but I am not aiming at any such nicety of calculation, and simply wish to give the young mechanic a practicable rule which he can readily apply in his daily business, and if he is a good enough arithmetical scholar to calculate a square root readily, and to remember the radius of a circle to be one-half its diameter, and the semi-circumference to be 1.57 times the diameter, he can get along without any reference books whatever.

I may also add that if greater mathematical accuracy in the ratio of speed should be desired, the thickness of the belt should be deducted from the diameter of each pulley. As the center of motion is found to be in the center of the belt, or half its thickness from the pulley, and where the ratio is as great as 10 to 1, this will make a perceptible difference in the actual speed attained.

My attention has been called to the point, that in case of a large difference in the size of the pulleys this mode of calculation would not be quite correct, as shown in Fig. 2, when the distance from the center line to center line would be rather less than if the belt followed the curve of the pulleys, as from x to 1.

To this I reply that in so short an arc of the circumference, more or less than 180°, as is commonly touched by the belt, the difference between the arc and the chord would be scarcely perceptible, and not worth taking into account, as the elasticity of the belt would compensate for it, and it would be in the opposite direction from the error caused by the difference of the radii, used as a basis, and that attained by calculation. The radii given for ten speeds above, is that of the basis to start with, and not the final result. The enclosed sketch shows an exaggerated illustration, as the distance between centers is less than the diameter of the larger pulley, while in practice it would usually be from 4 to 5 times that, or perhaps more.

* * *

TYPICAL EUROPEAN MACHINE TOOLS.—4.

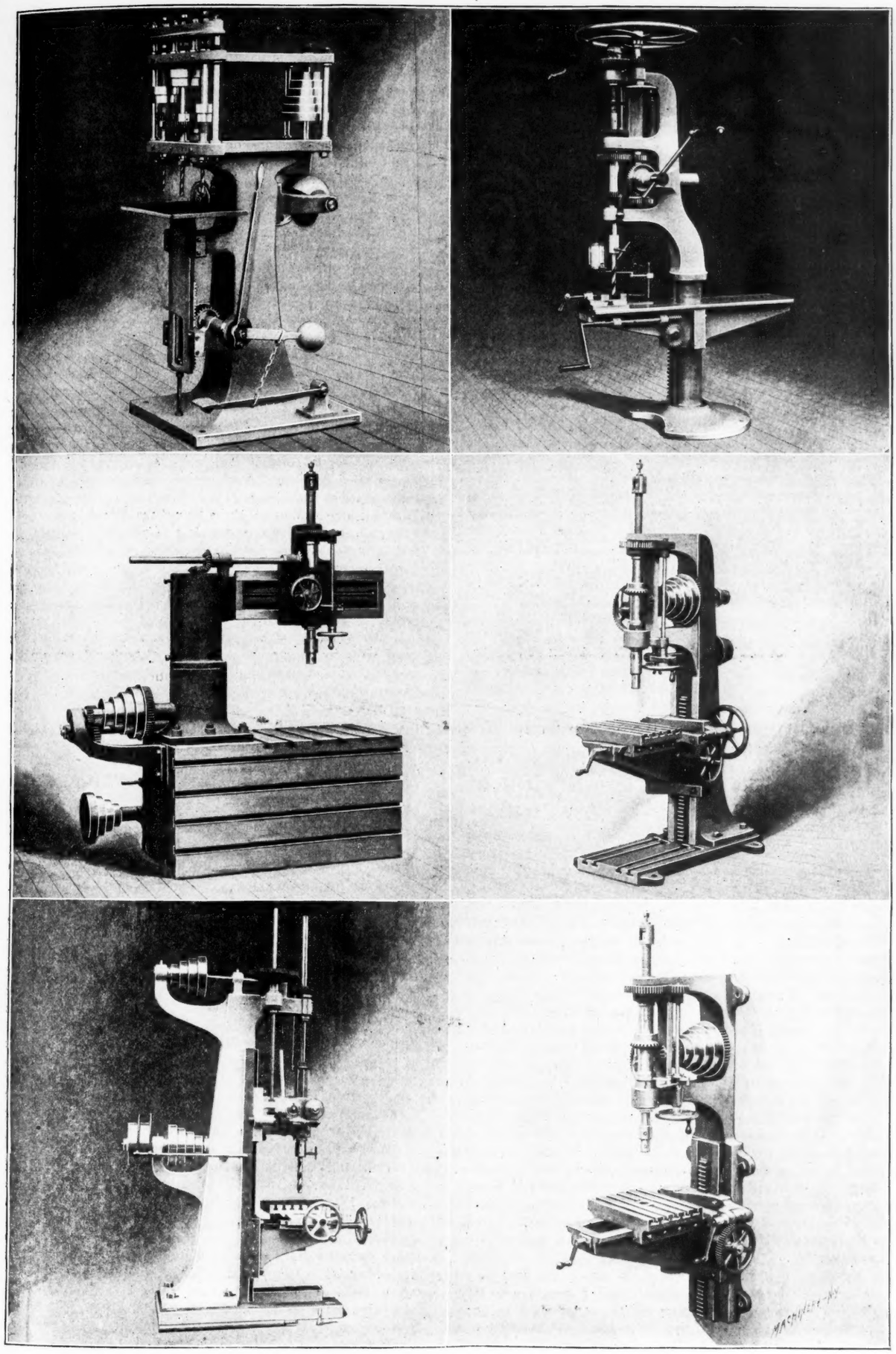
DRILLING MACHINES.

The full-page illustration in this issue represents some types of drilling machines commonly met with in European shops.

A noticeable difference from our American practice is found in the construction of the table designed to hold the work to be drilled. Our machines corresponding in size to those presented have an arm or knee projecting from the main stand, which generally carries a circular table. This table can be revolved around its vertical axis. Some of the illustrations show the knee holding a carriage, which by means of a screw and handwheel can be displaced horizontally to or from the main stand of the machine. In many instances this carriage has two motions at right angles, the idea being to clamp the piece to be drilled fast to the table and then move the latter to suit the work. The writer has often had occasion to observe a workman handling one of these machines, dispensing with the trouble of clamping a piece to the table, thus defeating the well meant intentions of the man at the drawing-board to place at his disposal extra conveniences. This looked like a case where theory was not modified by shop experience, as it should be. Our friends across the water, however, have no doubt sufficient arguments to defend this design.

Drilling-machines, more than any other class of machine-tools, permit of a construction which allows them to be fastened to a wall, instead of standing free on the floor. This type is more the outgrowth of local conditions, and might therefore be termed a "special" machine. In modern shops it is seldom met with where the room along the walls is almost invariably given up to bench work. In Europe it will no doubt hold its own for some time to come.

C. C. S.



EUROPEAN MACHINE TOOLS—DRILLING MACHINES.

COPYRIGHT, 1898, BY THE INDUSTRIAL PRESS.

Entered at the Post-Office in New York City as Second-class Mail Matter.

MACHINERY

A practical journal for Machinists and Engineers, and for all who are interested in Machinery.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

9-15 MURRAY STREET, NEW YORK CITY.

ONE DOLLAR A YEAR, POSTAGE PREPAID, TEN CENTS A COPY.
FOREIGN SUBSCRIPTIONS ONE DOLLAR AND FIFTY CENTS A YEAR.

Lester G. French, Editor.

Fred E. Rogers, Associate Editor.

The receipt of a subscription is acknowledged by sending the current issue. Remittances should be made to THE INDUSTRIAL PRESS, and not to the Editors. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Domestic trade is supplied by the American News Company or its branches.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

FOREIGN AGENCIES OF MACHINERY.

AFRICA.—Cape Town: Gordon & Gotch.—Johannesburg: Sherriff Swingley & Co.
AUSTRO-HUNGARY.—Vienna: White, Child & Beney; F. A. Brockhaus; Lehman & Wentzel.—Budapest: Ormai & Co.; Jos. Schvarcz & Co.; Szekely & Kaldor.
AUSTRALIA.—Adelaide, Victoria: W. C. Rigby.—Brisbane, Queensland: Gordon & Gotch.—Melbourne, Victoria: Gordon & Gotch.—Townsville, Queensland: T. Willmett & Co.
BELGIUM.—Antwerp: L. Verstrepen-Ellaerts.—Brussels: Librairie Castaigne, Montague aux Herbes Potageres, 22.
CHINA.—Hai Phong, Tonkin, Indo-China: E. C. Chodzko.
DENMARK.—Copenhagen: V. Lowener.
EGYPT.—Alexandria: G. Artuso Molino.
ENGLAND.
London: Buck & Hickman, 280-281 Whitechapel Road: C. W. Burton, Griffiths & Co., 158 Queen Victoria street; Chas. Neat & Co., 112 Queen Victoria street.—Manchester: Henry Kelley & Co., 26 Pall Mall.
FRANCE.—Paris: Boyveau & Chevillet, 22 Rue de la Banque; L. Roffo, 58 Boulevarde Richard Lenoir; Fenwick Freres & Co., 21 Rue Marbeuf.
GERMANY.—Berlin: F. A. Brockhaus, 14 Oberwallstrasse, W.—Dusseldorf: M. Koyemann.—Mulhouse: H. Stuckelberger.
HAWAIIAN ISLANDS.—Honolulu: Hawaiian News Co.
HOLLAND.—Rotterdam: H. A. Kramer & Son.
INDIA. Calcutta: Thacker, Spink & Co.
JAPAN. Nagasaki: Lake & Co. Yokohama: Andrews & George.
JAVA. Tegal: W. J. Amons.
MEXICO. City of Mexico: F. P. Hoeck.
NEW ZEALAND. Aukland: J. Flynn.
RUSSIA.—Moscow: J. Block & Co.; Mellier & Co. St. Petersburg: Wossidlo & Co.; F. de Szczeyanski; Carl Ricker.
SPAIN.—Barcelona: Librairie A. Verdaguer. Madrid: Librairie Guttenberg.
SWEDEN.—Stockholm: B. A. Hjorth & Co.
SWITZERLAND.—Zurich: Mayer & Zeller.
TURKEY.—Constantinople: V. L. Levy.

MARCH, 1899.

The regular edition of MACHINERY for March is 16,500 copies, which is the largest circulation in its field, and to those interested we shall be glad to furnish proof of this statement. AMERICAN MACHINERY is the title of the foreign edition of this journal, which is printed on thin paper and comprises all the reading and advertising matter in the domestic edition.

* * *

CHANGE OF ASSOCIATE EDITORS.

With this number of the paper Messrs. W. L. Cheney and A. L. Graffam sever their connection with MACHINERY, and Mr. Fred E. Rogers becomes the associate editor. This change takes place because of the increasing demands upon the editorial department, incident to the growth of the paper, which now requires the full services of an associate.

As is well-known, Mr. Cheney is the secretary of the Meriden Machine Tool Co., and has been a constant and valued friend to MACHINERY since its first number. His company, however, is meeting with so generous a share of the ruling prosperity, that it requires his undivided attention and he feels that he cannot do justice to his editorial work. Mr. Graffam has traveled among the shops in this country and Canada, in the interests of MACHINERY, and has contributed notes from several hundred shops, which have been one of the most interesting and valuable features of the paper. He is at present pursuing studies in several branches, in which he wishes to perfect himself, and prefers to retire temporarily from editorial work, rather than abandon his studies. Both Mr. Cheney and Mr. Graffam will be frequent contributors and we shall have their continued support in every way possible.

Mr. Rogers is well equipped for his new duties, both by study and an extended practical experience. He has written many articles for the leading mechanical papers and they have been of marked value from a practical standpoint. It is the constant effort of the editors to make MACHINERY a better paper with each succeeding issue and our readers are to be congratulated that Mr. Rogers has consented to join in this important work.

REFINEMENTS IN MACHINE DESIGN.

In structural design, the material is valuable and is used in such quantities that it pays to figure within narrow margins. A few years ago, for example, a bridge was built where the head room under the floor was limited, and it was at first intended to use shallow floor beams with heavy flanges, but it was later found that by curving the upper edge of the beam from end to end, to conform to the crowning of the road bed, the requisite strength could be obtained without the heavy flanges and at a saving of $1,000. It is not until recently, however that we have met with a parallel case in machine design. A few days ago we had the pleasure of examining a remarkably complete set of drawings for a Corliss engine, in which the details had been worked out with the greatest care by an expert designer. The bed was of the T-section type, and had a rib running along the whole length of the web at the back. This rib, instead of being of one size throughout, was made wide near the pillow block and narrow near the cylinder, because the designer found that the twisting moments introduced at the pillow block produced greater stresses at this point than existed near the cylinder, and he made the rib conform theoretically to those stresses at every point.

Most designers would pronounce life too short and material too cheap to attempt any refinements of this nature in machine design. What is required is stiff frames, plenty of material distributed in approximately the right proportions, and ample bearings. Most designers try to err on the right side in regard to these matters—have a little too much metal, and a little too large bearings. Many of these points are determined entirely by eye, or by using the very simplest calculations. Commercially it does not pay to go into refinements where equally good results can be secured by other methods, and on the other hand it certainly does pay to go into refinements when as good results cannot be obtained in any other manner. The difficulty is to know where to draw the line.

Let us consider a few illustrations, showing where the line has been wrongly drawn, and indicating, perhaps, certain points of difference between good and bad methods in machine design.

Any machinist who has run one of the so-called "New England type" of lathes, with weighted carriage, and as it was made fifteen or twenty years ago, knows, that when taking a fairly heavy cut the carriage would not stand up to the work. The tool would wince every time there was any extra metal to come off or it ran into a hard spot. Any machinist knows also, how impossible it is with certain types of milling machines to keep the cutter down to the work, because the machine is not stiff enough. Nor is this fault confined to ma hine tools. There are running in an office building in New York City a number of new, high speed engines, with their rocker brackets vibrating as though they were parts of the valve gear itself. This may do no harm, but it was not good designing, and the point that we wish to make is this: It pays to consider very carefully what stresses will occur when the machine is in operation, and to so distribute the metal that they will be taken care of and the machine will proceed with its work without yielding or vibrating. It may not pay to figure out to a nicety just how much metal will be required to do this, as in the case of the Corliss engine bed previously mentioned, but it shows incompetent designing if the stresses are not provided for, however the amount of metal may be determined. In nine cases out of ten, if the forces acting in a machine are understood, the parts can be proportioned for their work without any complex calculations.

A common failing in machines of all classes is the liability of the small parts to wear out rapidly. It is not uncommon to find a planer with heavy uprights and bed, with a powerful drive and steel driving gear, ample ways, well lubricated, but with a flimsy feed motion that soon becomes loose in the joints. Heavy engines for street railway traffic often suffer with the same disease. The shafts, cross-heads, connecting-rods and all the larger parts, are ample for the work and are equal to the calls made upon them, but the valve gear and the other small parts are so inadequate that they rattle and groan under the frequently varying loads. They have not been strengthened and their dimensions increased in proportion to the work they have to do.

Good machine design demands that the small parts be as well calculated to stand up to the work as the main bearings of a machine, and we would suggest that it is here that in the majority of cases the mathematics and refinements can be most profit-

ably introduced. It is a simple matter to determine, for example, the forces acting in a planer feed motion and there is no more excuse for making it too frail for the work than there is in using a flimsy cross-rail. Sometimes a lathe will run for years without wearing out the main bearings to an appreciable extent, and some of the smaller bearings ought to be made to do as well.

* * *

PUSHING THE WORK.

One of the most difficult problems that a superintendent of a large concern has to solve, is that of pushing through the work from the time when the pattern shop begins on an order, to the time when the completed machine stands on the erecting floor ready for shipment. It involves ordering in the stock, ordering the castings, finding whether there are enough duplicate parts such as bolts, pins, etc., in the stock room, and finally, following the different pieces from one department to another, until everything is ready to go together. When castings are defective or work is spoiled new castings and new pieces must be made and care must be taken that nothing be side-tracked in some dark corner of the shop, lest there be a missing bolt or some other insignificant piece to delay the erectors and hold the machine an unnecessarily long time on the erecting floor.

The problem becomes, if anything, more difficult of solution when the shop is arranged according to the modern idea, with the different machines of each kind grouped together in a department under a department foreman. The different foremen then lose track of the work as a whole, and are concerned only with those operations that are to be done in their own departments.

Where a regular line of machinery is made and carried through in lots, the foremen, as well as the workmen, soon become familiar with it and know what to expect, just what is to be done and when it is to be done, and no particular delay or difficulty need be experien ed after the work is once fairly under way. Few superintendents, however, are blessed with such favorable conditions. Besides, perhaps a large number of regular machines, most men in charge of a plant have special machines, stock orders, jigs and fixtures, newly designed machines, and more or less repair work coming through the works at one time. Some of these are rush orders, some must be delivered within a certain number of weeks and others will answer within as many months. To keep track of these and have everything come out right at the end, is no small matter, and we shall be pleased to open our columns for a discussion of methods that have been used successfully for conducting this part of the management of a plant.

Whatever plan is adopted, it is quite certain that it should not involve too much personal attention on the part of the superintendent. Much of the work can be done by clerks and the superintendent's time should be free for some of the larger affairs connected with the management. On the other hand, there is nothing quite so efficacious, as to have some person in authority make the rounds of the works once or twice a day, to inquire into the progress of the work, give directions as to what parts shall go ahead, and unravel any difficulties that may have arisen. In a shop of even moderate size, the situation seems to demand a general foreman or possibly an assistant superintendent, whose duties shall be to relieve the superintendent of some of the details connected with pushing the work, that inevitably take much valuable time. Many shops do without such a person and depend upon clerks, otherwise called "chasers," superintendent's assistant, or upon the superintendent himself, to keep the work moving in proper order. It appears to us, however, that the first requisite in any case, and whatever the system, is to have this important duty in the hands of some one person who has a knowledge of all the conditions and who has full authority to execute his orders.

One desirable rule to adopt, is, that when one department is through with a piece of work, the piece shall be sent at once to the department where the next operation is to be performed. For obvious reasons it is better to have work accumulate around the machine where it is to be done, than around the machine where it has been done. It is in human nature to feel better contented and to do more work, when one sees work ahead, than when he does not. If this rule be adopted, moreover, the machine is less likely to stand idle through lack of work and the work is less likely to be delayed through failure to have certain operations performed when the machine is ready to do them.

WAGES AND PRODUCTION.

A DISCUSSION OF CO-OPERATIVE PLANS AND THEIR EFFECT UPON PRODUCTION.

ARTHUR A. FULLER.

Machinists are sometimes heard to bemoan the low market rate at which their labor is held, and young men often hesitate in regard to undertaking an apprenticeship because of a fear that the market rate is steadily declining. The market rate is affected by locality to some extent, following the law of supply and demand, but is still further affected by the skill and ability of the machinist. If men were rated solely according to their skill or productiveness there would be a still wider range in the rate of wages. It is a commonly known fact that some men can produce twice as much work as others in a given time. This is true, especially where much depends on skill in measuring, rapidity in handling, etc., or where opportunity is present for talent in arranging the work.

As far as day rates are concerned it would be an advantage to machinists in general if the rates were apportioned according to skill and productiveness. It would not only give the best man a more just equivalent for his work, but it would encourage the medium man to endeavor to become the best. Any more equitable method of scaling the rates for machine labor would tend to clear the atmosphere for those who are in doubt. An even rate for all machinists greatly handicaps the most skilled labor and benefits only the lazy and incompetent. Our present rates lie between the even rate and a rate based upon the actual value of the production. The rates fail of being fixed more strongly by the latter influence, for two reasons; first, because of a disposition on the part of most employers to fix a maximum rate beyond which they will not go; second, because of a disposition on the part of machinists to demand a fixed rate, regardless of the skill and capacity of the individual.

These two dispositions, lying parallel to each other and conducing to the same results, are nevertheless actuated by a certain antagonism between employer and employed. Could this antagonism be removed the disposition on the part of both employers and machinists toward a rate of wage based upon the skill and actual productiveness would be fostered and increased.

Without entering upon an extended discussion of the labor problem, it may be said that the causes of the existing antagonism are selfishness and greed, engendering mean and false dealing on both sides. To remove a cause so deep seated in human nature may seem a hopeless task.

"Confidence and Co-operation."

Honesty should be practiced, not only because "it is the best policy," but for the sake of honesty itself. But many of the benefits of honesty may be experienced even when practised as a policy, and although it may not be possible to change at once the motives of both men and employers it may be possible to obtain a portion of the benefits of a policy of unselfishness and liberality. Such a policy would necessitate on both sides fair and square dealing, in order to cultivate a spirit of confidence, and a system of co-operation in profits in order to cultivate a disposition in the employer to give highest possible wage, and in the machinist to give his highest possible production. The two most practical watchwords to this end might be said to be "confidence and co-operation."

The honesty and fair dealing we must leave to the policy, if not to the consciences, of men and employers, with the hope that at least honesty will prevail. The co-operation almost necessarily emanates from the employer, who feels at liberty to choose such methods as appear to him best adapted to his business. When once put in motion, however, many valuable suggestions will come from the workmen, as there are two sides to every problem, and it is the essential feature of co-operation that both sides be equally considered.

Many schemes of co-operation have been attempted in the various trades and factories with varying success. Many schemes have been too complicated, and many have a serious drawback in the length of time necessary before the workman knows to what extent he has participated in the profits. Many schemes are too visionary, and some good ones may have been failures on account of the methods taken to introduce them. Any plan, to succeed, must be practical and simple enough to introduce without displacing entirely the old. The most practical schemes seem to be those in which the workman is able to

participate in the profit on a given piece. That is, he is given an opportunity to reduce cost of production and is allowed an increase of wage for so doing.

The piece work plan is the most widely introduced of any system in which the machinist shares in his increased productiveness. It consists in paying a fixed price for a certain piece of work. It is entitled to a place among schemes of co-operation, in that it really stimulates the man to increased effort, and at the same time increases his pay. But on account of the frequent cuts made by manufacturers, necessary as they may have been and still are, it has not only failed to promote the best spirit of co-operation, but on the contrary has aroused so much antagonism that any new plan having in it elements of co-operating in a similar way is looked upon with displeasure by the workman. Although it was originally intended to benefit the manufacturer, in its first result it most directly benefited the workman, as he received an increase of wage, while the price per piece remained constant to the manufacturer, who, however, gains something by the greater output of his plant. Why, then, should not the workman be satisfied? It has in reality been a boon to his pocketbook. The difficulty lies in its uncertainty; he never knows when the price is to be cut, and consequently is shy of exhibiting his best production through fear of further cuts.

The Differential Plan.

The differential plan consists of paying a man a high price per piece in consideration of his reaching a certain high water mark of production per day, and a lower price per piece provided he falls below this rate of production. This plan congregates the ablest of workmen, but leaves the medium men considerably in the shade. It is a sure scheme for a manufacturer, but difficult of introduction into an ordinary machine shop doing a large variety of detail work. It necessitates a radical change from the method of paying by the hour, but perhaps conforms more closely than any other plan to the true theory of having the wage proportionate to the production.

The Premium Plan.

The premium plan consists of setting a "time limit" upon the piece, within which limit the piece is expected to be completed. The man is paid his hourly wage for every hour he works upon the piece, and a specified premium for every hour he saves or does not work upon the piece inside the "time limit" set. The "time limits" and premium rates are not changed or cut. The advantages of this plan are: First, adaptability to ordinary work fitting in alongside of regular day work; second, its self-regulating feature, whereby the cost per piece is reduced to the employer and the wage per hour increased to the workman every time any improvement is made in production; third, its flexibility, due to the opportunity at the start of fixing a premium rate adapted to the conditions of business in hand, and the opportunity thereafter of setting either a liberal or close "time limit" to regulate cost per price. It does not crowd out the medium machinist, but gives him encouragement to become better.

It also serves the foreman as the best indicator possible for setting the rates of men per hour, by affording him an opportunity to note the amount of product turned out in a given time.

Of these three plans of co-operation on the piece, the piecework plan requires the least knowledge in fixing prices, as they are subject to revision at any time; the differential plan requires a most extensive, minute and complete knowledge of the exact maximum rate of production possible; the extent of knowledge and experience required is appalling, and partly accounts for the small number of general machine shops which have adopted it. The premium plan requires a fair knowledge and judgment of machine-shop operations, in order to set a reasonable "time limit," but with proper premium rates the "time limits" may vary considerably, without varying the actual cost to a dangerous extent. This plan is doubtless not the best that can be devised, but it appears to be the most practical yet advanced.

Although co-operation, as a policy, may be partly successful, to be most thoroughly and entirely successful it must be practiced from motives of unselfishness. It must have at its head a man with firm convictions that the co-operative plan is right; and one who realizes also that the price per piece must be as low as the cost of like pieces in his competitor's shop. The machinist should be in sympathy with the plan, because it allows scope for individual talent and an opportunity for increase of wage. The plan must have the sympathy and aid of the foreman in setting "time limits," and the general management should base their approval or dissatisfaction upon the general result, and not by the apparently liberal "time limits," or the occasional excessive wage rate which is liable to occur.

It is the tendency of the times to regard the rate of production as a more potent factor in the elements of cost than the rate of wage. From an economic standpoint, this is doubtless true within certain limits, so the co-operative shop that can find and adopt just this limit may be said to be surest of success. The tendency of shop managers to keep down the wages will doubtless be strong for some time to come, and may cause failure of the co-operative plan in some cases. On the other hand, a case might arise where the rate of wage would be higher than the rate of production would warrant; such conditions would inevitably lead to failure. The only safeguard against failure in both directions is the first of our watchwords, "confidence." Could this feeling of confidence between machinists and their employers be firm and fast there would be little danger of failure.

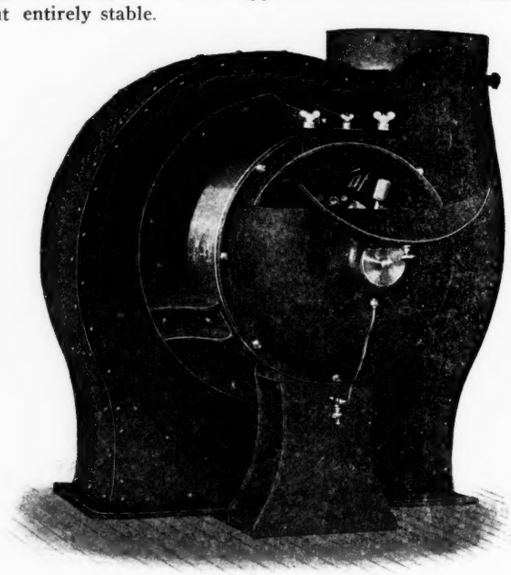
With the machinist doing his level best at production, and the employer striving to pay him the highest admissible wages, the problem of the proper relation between wages and production would be in progress of solution.

* * *

STEEL PLATE ELECTRIC FAN WITH ENCLOSED MOTOR.

One of the great difficulties in employing an electric fan under certain conditions lies in the prevalence of dust in the atmosphere, which would ultimately injure or derange the motor. To obviate this difficulty, a special type of fan, with enclosed motor, has been designed and is being built by the B. F. Sturtevant Co., of Boston, Mass.

As shown in the illustration, the fan itself is of their usual steel plate construction. To its side is attached a cast-iron plate having three projecting lugs. These center and support the field ring, while a light cast-iron support renders the whole arrangement entirely stable.



NEW MOTOR-DRIVEN FAN.

The motor itself is of the four-pole type, the armature being barrel wound, and the general construction such as to best suit the conditions specified.

Carbon brushes and reaction holders are employed, and the entire design is made such as to insure continuous operation without sparking, even when left untended for considerable periods of time.

The hemispherical casings, which are bolted to the sides of the field ring, serve to entirely enclose the motor, while the door in the outer casing renders it perfectly accessible.

Ring oiler bearings support the shaft, and all trouble from oil is absolutely avoided. Fans of this type are primarily constructed for ventilating purposes, and under such conditions create pressures of about 1 oz. per sq. in. They can, however, be constructed to create higher pressures, and to serve as exhaust fans for the handling of refuse material.

SHOP TALKS WITH YOUNG MECHANICS—12.

RULES, SQUARES, STRAIGHT EDGES, HACK SAWS, SCREW DRIVERS AND WRENCHES.

W. H. Van Dervoort.

No tool in the machinist's kit is more often referred to than the steel rule. Upon it he depends in making all ordinary measurements and for the setting of his calipers and dividers. In Fig. 200 is shown a standard steel rule or scale. They are made

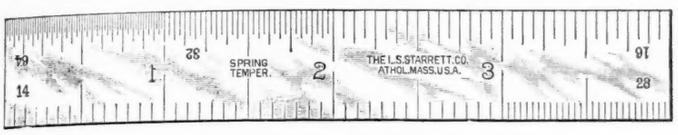


FIG. 200.

in various lengths, from one to forty-eight inches, with any desired gradation, not exceeding 1-100 of an inch in fineness. For shop work the graduation most used is eighths, sixteenths, thirty-seconds and sixty-fourths, on the four corners of the scale. A

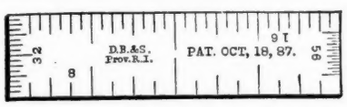


FIG. 201.

scale graduated sixteenths, thirty-seconds, sixty-fourths and one-hundredths, is convenient, as the 100ths graduations will serve for measurements when required in decimals. Where all the work is measured by fractions, however, the former is the safest ruling to use, as there is then no danger of inadvertently mistaking a tenth for an eighth division, etc. For this reason, rules graduated in twelfths and fourteenths should not find their way into the machinist's tool box, as he will not have occasion to use these divisions, and their presence will call for greater care in selecting the proper division, with the loss of time incident to changing ends with and turning over the rule in order to get at the division required. The end graduation, as shown in Fig. 201, is frequently very convenient in taking measurements in recesses where the length of the scale would prevent the use of the regular graduation.

Standard steel rules, as made by our leading makers, are remarkably accurate. To be sure, the length varies slightly with the changes in temperature, but these changes are not ordinarily

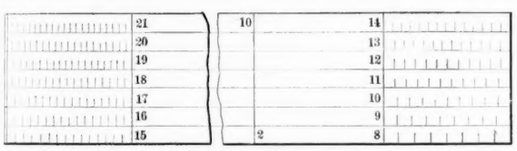


Fig. 202

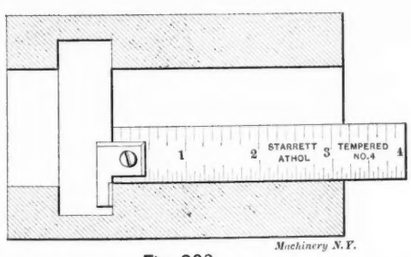


Fig. 203

great, and the material measured is usually affected about the same amount in the same direction; so we may feel assured that any errors arising from this source are well within the limit of the personal error of the operator in making a measurement.

The late refinements in the manufacture of steel rules have enabled the production of very accurate tempered ones on comparatively thin steel. What we usually know as the standard rule, however, is graduated on thick steel, and is not tempered. The tempered rules possess the decided advantage of resistance to wear. An untempered rule is easily mutilated, and soon rounds its corners through wear, making its ends unfit for reference. The tempered rules may be classed as heavy, tempered, semi-flexible and flexible. The heavy are about one-tenth; the tempered, one-twentieth; the semi-flexible, one-fortieth, and the flexible one-eightieth of an inch thick. For general work the heavy or tempered will be found best suited. The flexible are graduated on one side only, and are of value in measuring curved or irregular outlines.

In this connection it will be well to call attention to the gear rule shown in Fig. 202. Its application is in the sizing of gear blanks and where, by rule of thumb, two diametrical pitches are added to the pitch diameter of the gear in obtaining the whole

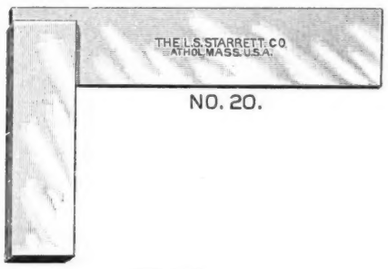


FIG. 204.

diameter. Thus, if the pitch is No. 7 diametrical and the number of teeth 34, then the pitch diameter $= 34\text{-}7 = 4\ 6\text{-}7$ inches, and the blank or whole diameter $= 4\ 6\text{-}7 + 2\text{-}7 = 5\ 1\text{-}7$ inches, which can be taken directly from the scale. This rule is of great convenience where many blanks for varying pitches and numbers of teeth are to be sized.

In Fig. 203 is shown a neat kink which will be found of value in taking measurements similar to the ones shown in the figure, as well as for setting inside calipers. The hook may be quickly removed. It is hardened, and in connection with a tempered rule forms a reliable tool.

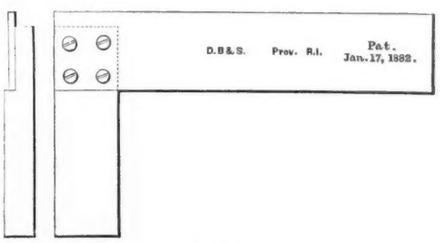


FIG. 205.

In Fig. 204 is shown a standard steel square. This tool is made of cast steel, tempered and accurately finished. The two sides of the angle are called the blade and the beam, the length of the blade being measured from the inside of the beam. The form shown in Fig. 205 is preferable when the length of the blade exceeds eighteen inches, as it can be more readily repaired in case of accident.

Either of the methods shown in Figs. 206 and 207 may be used by the machinist in testing the accuracy of a square, the latter being the more exact of the two. In Fig. 206 A is a plane plate of iron with one edge, BC, perfectly straight. The surface A should be smooth and true. The square is first applied as shown at F and a file line DE scribed along its edge. It is then re-

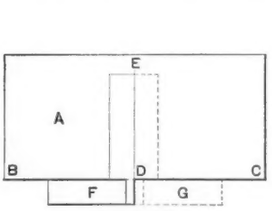


Fig.206

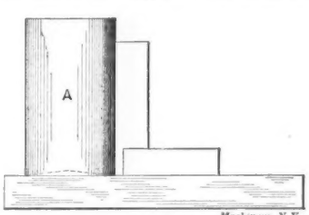


Fig.207

versed to position G, when, if the edge exactly lines with the ruling DE, the square is correct. If, however, the edge and line do not coincide, the square is inaccurate by one-half the variation as shown. Since this method depends for its accuracy on the eye of the operator it cannot be called an exact one. The method shown in Fig. 207 reduces the amount of the personal error, since the eye detects readily the ray of light that passes through an exceedingly small opening. In the figure the cylinder A, which has been ground accurately parallel and faced on

the lower end slightly dishing, rests on a plane surface, a standard surface plate being best suited to this purpose. As the surface of the cylinder is at right angles to the surface of the plate the square can be compared with this angle by placing it as shown in the figure.

For most general work the thin steel squares shown in Fig. 208 serve very well. They are cut from sheet steel, carefully made but not hardened, and are usually graduated, as shown, on both sides.

The combination square shown in Fig. 209 is a satisfactory tool, which, with careful use, retains its accuracy. The blade is readily adjusted to any required length, which is of special value in transferring measurements. The 45 degree angle is of frequent value, as is the centering head which is used on the blade as shown. The blade is a standard steel rule, splined to receive the key which draws the edge of the blade close to its seat in the beam.

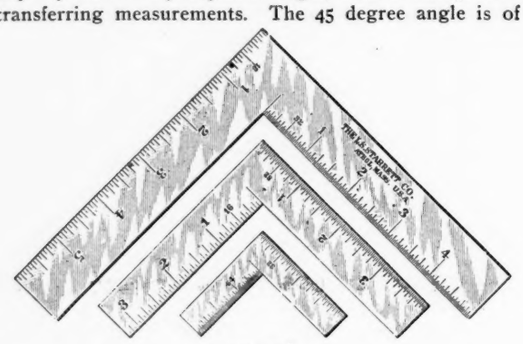


FIG. 208.

In Fig. 210 is shown a box square, or as it is more commonly known, a key seat rule. With this tool lines upon a cylindrical surface parallel with the axis may be drawn. While it is intended for use on external surfaces, as shown at A, Fig. 211, it will at times serve a good purpose on internal, as shown at B, same figure. A form of box square, shown in section in Fig. 212, possesses the advantage of wider range than that of Fig. 210.

For a great deal of this work the machinist is satisfied with using the edge of a good steel rule to determine its straightness; but when he wants to know to a certainty that the work is straight it is a source of great satisfaction to be able to refer to a standard straight edge. Such a straight edge is shown in Fig. 213. It is a piece of steel of thickness depending on its length, nicely finished, with its two edges parallel with each other and straight. They are regularly made up to six feet in length, such a tool being about three inches wide by three-eighths of an inch thick. Up to four feet in length they are frequently tempered on the edges.

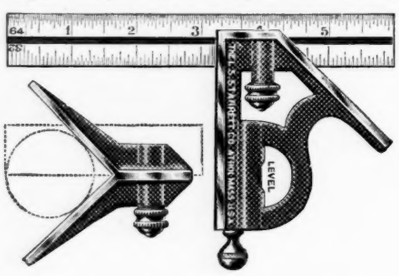


FIG. 209.

A cast iron or surface straight edge is shown in Fig. 214. These tools are designed for an entirely different class of work than the one shown in Fig. 213. The edge is wide and scraped to a true plane, with the body so formed as to best resist deflection from its own weight and distortion due to changes in temperature. These straight edges are used in the production of long plane surfaces like planer bed V's and lathe shears, precisely as the surface plate is used in the production of broad plane surfaces, and they are generally much larger and heavier than the style shown in Fig. 213.

Hack saws are used for severing purposes, both by hand and power, the comparatively recently introduction of the power hack saw machine having increased many times the possible usefulness of the hack saw blade, a cut of which is shown in a hand frame in Fig. 215. The original Stubs' and German blades were soft enough to be sharpened by filing, were made of excellent material, and were high in price. Their expense and the trouble required to keep them properly sharpened limited their use to a narrow range. The bringing out of the modern hard blade, at a price sufficiently low to warrant throwing it away as soon as it became too dull to do satisfactory work, has practically superseded the old blade and made the hack saw one of the most important tools in the machinist's kit.

FIG. 210.

Hack saw blades are made with fourteen teeth per inch for general work. When, however, they are to be used on tubing or thin metal a greater number of teeth is advisable, as they will not bite so freely, and the danger of stripping the teeth is much less. For this purpose blades having twenty-five teeth per inch may be had.

As with a file, the fineness of the bite depends on the number of teeth in contact with the work. The judgment of the operator must, therefore, determine what pressure to apply on the saw for the varying conditions of cut. As with other cutting tools, the hack saw does more work and stands up to it better when the pressure is sufficient to make the teeth cut free, rather than scrape and glaze the surface, as is the result when the pressure is too light. The blade must be strained in the frame to prevent its kinking. The strokes should be uniform, not exceeding forty per minute. Oil should not be used on the teeth, as it decreases their cutting efficiency. Blades are regularly made from six to eighteen inches long, those exceeding twelve inches being little used. For any work the blade should be as short as possible, as the cost of the blade and danger of breakage decreases with its length. Blades longer than eight inches for hand and twelve inches for power frames are seldom required. The frame should be stiff. In this respect the non-adjustable, or solid one, shown in Fig. 216, is preferable. All hand frames should be so constructed that the blade can be faced at right angles to the position shown in the figure, which is quite necessary when a deep cut is to be taken near the edge of the work.

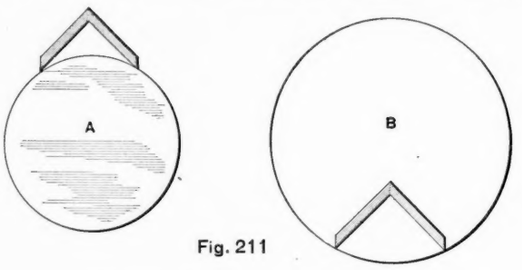


Fig. 211

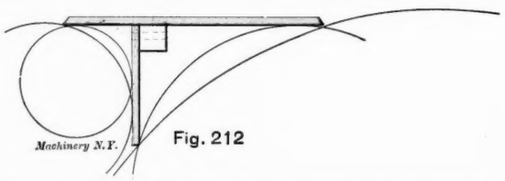


Fig. 212

FIG. 213.

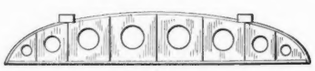
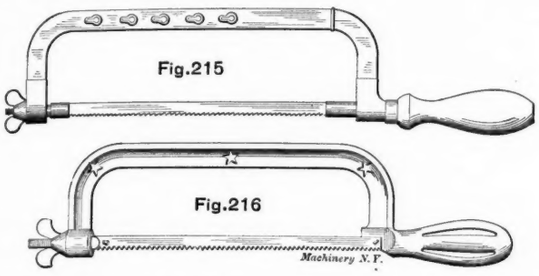


Fig. 214

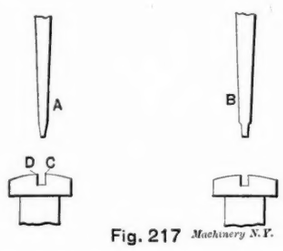
Everybody uses the screw driver, yet how seldom, even among mechanics, do we find it properly ground. In Fig. 217 is shown at A an edge view of the point of a screw driver, as usually ground; and at B a view showing how it should be ground. When the screw driver, A, is applied to the slot of the screw

head it bears only at the center of the upper edges, C and D, of the slot, and the force required to turn the screw forces the driver out of the slot, which injures, if not completely ruins, the head of the screw. With B the case is different. The parallel sides of the bit takes squarely hold of the sides of the slot and the screw is driven without injury, and with much less exertion than in the former case. The screw driver should be made of good tool steel and given a tough temper.

In Fig. 218 is shown that much used tool, the monkey wrench. This is a genuine wrench, and should only be used as such. It

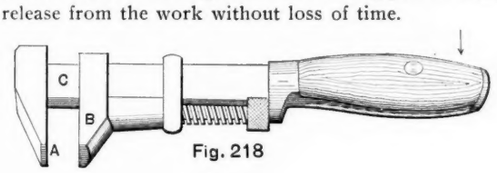


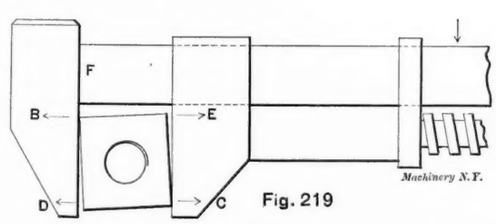
should never be used as a hammer; neither should it be expected to stand all the force a thoughtless workman can apply at the end of four feet of gas pipe slipped over the handle as an extension. It should, however, when properly closed onto the flats of a nut, stand safely all the average man would care to exert with both hands on the handle. As the nut often starts more easily with a quick jar or shock than by the application o. a steady force, it is permissible to strike the end of the handle in the direction shown by the arrow with a rawhide or wooden mallet, or the end of a soft block of wood. The operator's judgment must determine how heavy a blow he can safely use.



The surfaces A B should be smooth, plane, and parallel with each other. These wrenches usually fail by bending at C. If the bend is slight, A can be most easily be made parallel to B by filing, but when badly bent it should be carefully straightened.

The jaws of the wrench and the nut or square upon which it is being used will be least injured when the jaws are closed firmly onto the work. This necessitates slacking them slightly and closing again every time the wrench is changed. By giving the hand a slight rolling motion around the handle, with the forefinger against the knuckled head of the wrench screw, a sufficient amount of motion can be given to the sliding jaw to close onto and release from the work without loss of time.





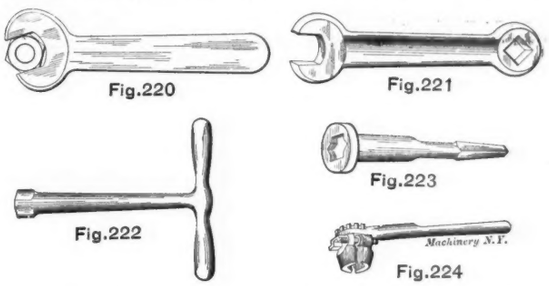
The sliding jaw, due to its long bearing on the shank, is much stronger than the fixed jaw, consequently the wrench should be operated in the direction of the arrow, Fig. 218. An examination of Fig. 219 shows than when turned as above indicated the maximum pressure comes at B and C, which places the shorter leverage on the weaker jaw. If turned in the opposite direction the pressure comes at D and E, which increases the bending tendency at F, and also the pressure on the screw.

The great variety of combination wrenches on the market possess little merit. When we use a wrench we do not want to have a hammer, a screw driver, a nail puller, and a dozen other "useful tools" in our way at one time.

When finished standard nuts are to be turned the solid wrench is preferable to the adjustable, as it can be made to fit closely to the nut with less danger of injuring it. In Fig. 220 is shown a finished case-hardened, solid wrench. The angle of the open-end is fifteen inches with the length of the handle, which enables a hexagon nut to be turned when the wrench can be carried through thirty degrees only. These wrenches may be had double ended. The box wrench has a closed opening, as shown in Fig. 221. This particular form is commonly called a tool post wrench.

The socket wrench, shown in Fig. 222, is made for square and hexagon nuts and cap screws, which are to be operated upon in deep or inaccessible places. When a great many small nuts are to be quickly set, the socket wrench, in Fig. 223, operated in a bit brace, does the work rapidly.

It frequently happens that a nut must be turned which is in so inaccessible a place that the handle of the wrench can be carried through only a few degrees. In such cases, the ratchet

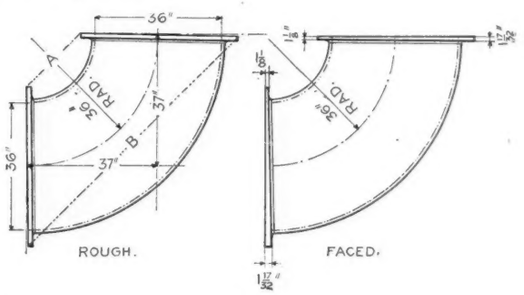


wrench, shown in Fig. 224, serves its purpose well, the effect on the nut being much more satisfactory than when the set chisel and hammer are used. In the use of all solid wrenches they must fit the nut closely, as otherwise both nut and wrench will be injured, the nut rounding and the wrench spreading.

* * *

THE SHRINKAGE OF ELBOWS.

I send you herewith a clipping from a mechanical paper, which is a question and answer in regard to the shrinkage of a segment of cast iron. For the benefit of the readers of MACHINERY, I will tell you what I know about this subject, particularly in regard to the shrinking of elbows.



I have seen in the last five years a good many large flanged ninety-degree, forty-five-degree, and thirty-degree elbows cast, and have noted the shrinkage in them closely. I send you a sketch of thirty-six-inch elbow, showing the casting rough, as it came from the foundry, and in another view faced with the thickness of the flanges, in figures so as to show how much the casting had shrunk out of square.

I have noticed that the shrinkage runs about the same proportion on smaller castings, and I would advise to allow for shrinkage in the direction of the dotted lines, or at right angles to the center line. From this, it will be seen that to have an exact ninety-degree elbow, with flanges of equal thickness all around, it is either necessary to make the pattern out of square, or, possibly, the molder can favor it by uncovering and cooling one side first, so that curvature will approximate that of the pattern. I have, however, seen a good many castings from different foundries, and they all show more or less the same fault.

SUBSCRIBER.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP. Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

TAPER BORING BAR.

While visiting the Norfolk Navy Yard, Mr. A. L. Graffam saw the boring of a taper hole in a propeller on a large upright drill press, and in the following description of the rig. he says:

I was somewhat surprised o see such a rig in Uncle Sam's shops, but think that it will be of interest to the readers of this paper.

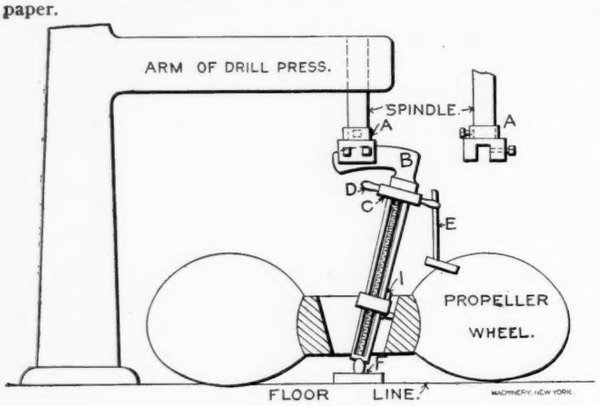


FIG. 1.

Nevertheless. I have seen many a shop where such a rig would be superior to anything they possessed in this line. The head, A, Fig. 1, fits on the end of the drill spindle, and the arm, B, of the boring bar is held in the slot through it by set screws, which permit the arm B to be adjusted to suit any taper desired. Automatic feed is produced by the usual star wheel, D, striking the rod E, which is fastened to the propeller.

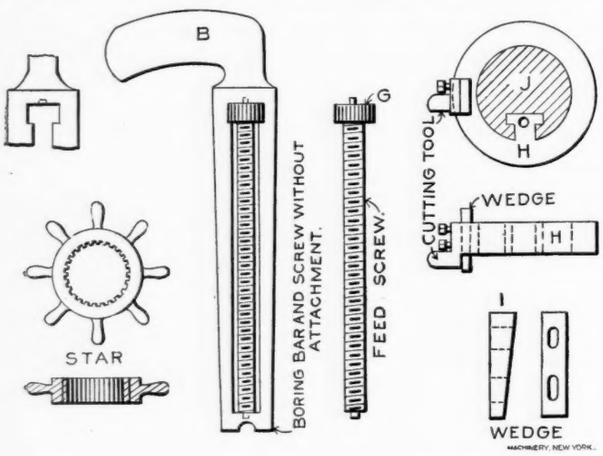


FIG. 2.

The ring, C, is secured by set screws, to hold D in position. The ball shaped center, F, is fitted into the bed plate. G, Fig. 2 is a gear fastened to the feed screw, and projecting far enough to mesh with the internal gear teeth in star D, which turns freely on boring bar B. The feed screw fits into a socket at each end. H is the tool holder, to which is fastened a nut on feed screw, by which it is fed up or down easily, yet it fits bar as closely as practicable. An end section of boring bar is shown at J, which also shows the tool ring, H. The tool is adjusted by slacking the screws and tapping wedge, I, with hammer.

ETCHING ON STEEL.

Mr. John J. Scully, of Bridgeport, Conn., sends the following interesting process for etching:

Mark the desired letters or characters with asphaltum, thinned with turpentine. The consistency should be such that it will present a substantial body and yet be free enough to run easily and dry quickly. Very little experimenting will give the desired result. Apply with a fine camel's hair brush.

For etching fluid mix of muriatic acid 3 parts, nitric acid 1 part. This relation varies somewhat, according to the strength of the acids; if too strong add more muriatic acid; if too weak, add nitric.

The acid should remain on but a few minutes; then dip the steel in water and wash the surface with benzine.

The most essential requirement is that the surface to be treated be clean. The best way to secure this is to rub lastly with a piece of new and dry emery cloth. Even the fingers must not touch the surface.

I think this manner of etching is not generally known. I tried a number of paints for marking, but found nothing to answer the purpose as well as asphaltum, although, in a way, japan is even better than this, insomuch as the acid will not eat through as readily, but it takes too long to dry.

This has many advantages over the old way of scratching through beeswax. It allows of neat lettering, is more easily discernable, and permits of a good deal of ornamentation, providing, of course, one is prone to what is quasi-sarcastically referred to as "flower-garden" tendencies.

There is no failure in etching as per the above instructions, provided the surface is clean—absolutely so.

NOISELESS RATCHET.

Mr. H. B. McCabe, of Cleveland, Ohio, writes as follows:

The substitute for a pawl and ratchet, shown and described by Fred. E. Rogers, in MACHINERY for December, 1898, reminds me of a device for a similar purpose, used in a small alarm clock, which I had occasion to dissect. I send a sketch, showing the principle, Fig. 3.

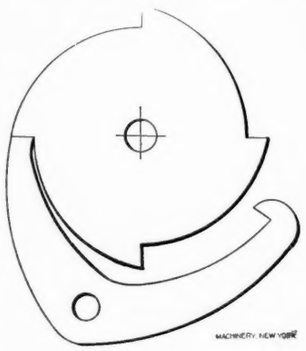


FIG. 3.

This is not a substitute for a pawl and ratchet, but, like the device shown by Mr. Rogers, it has no spring, and its action is practically noiseless. This little arrangement was found on the winding stem, the pawl being attached to the side of the first gear of the train, and, of course, must work in any position around the stem or shaft It may be seen that either one end or the other of the pawl is always in position to catch. It seems to work perfectly, and. I think the device can be used anywhere to advantages as a substitute for the ordinary pawl and ratchet, where the clicking noise is objectionable.

NOSE CHUCK.

The following bright kinks are submitted by "G.," and will be found interesting:

Fig. 4 is a piece of cast iron, threaded in one end, A, to fit on the spindle of a lathe and bored out at D and E. The opposite end is milled at C, as shown at B and G, about one-quarter inch deep and three set screws, I I I, are placed equidistant around the circumference.

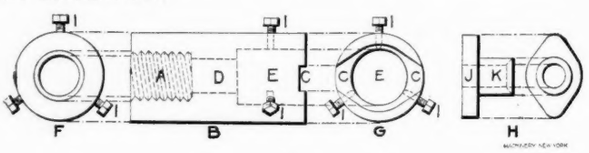


FIG. 4.

The chuck is for holding glands of the pattern shown at H. The end K is held in E by means of the set screws I, bored, and the side J faced off. The mandril shown in Fig. 5 is then placed in the tapered hole in spindle, the large part N fitting in the bore E of the chuck, and the end L projecting through. Upon the end L is placed the gland, with the side J fitting into the middle place, C, of the chuck. The end, O, is split, as shown at S, and the taper set screw R set up in the taper hole, thus spreading apart the mandril and tightening it in the gland. The gland can now be turned and transferred on the end. This device will be found to be very useful where much work of this kind is being done.

Fig. 5 shows another fo m of nose chuck for doing work similar to Z. The end is sawed across into quarters, as shown at

Y, and contains a taper hole, in which it fitted the taper pin X. Another taper hole at right angles to this is also fitted with the pin U.

After a piece of work similar to Z is bored out, it is slipped on

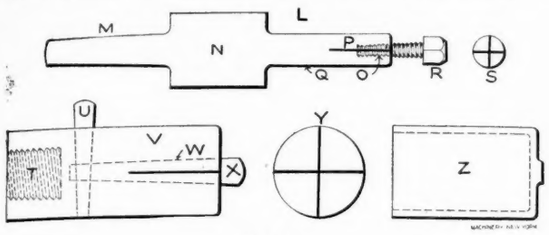


FIG. 5.

V and driven down, thus striking the pin X, and by spreading out the chuck it tightens the piece so that it can be readily turned. After being finished, it can be readily removed by inserting the pin U, which acts as a drift and forces out the pin X, and thus releases the jaws.

LOOSE PULLEY BUSH.

The sketch shows a loose pulley bushing that has been tested and gives satisfaction. Mr. J. D. Weir, Hamilton, Ohio, sends the description, in which he says that the bushing is made of cast iron, which makes a good running surface after it is worn bright.

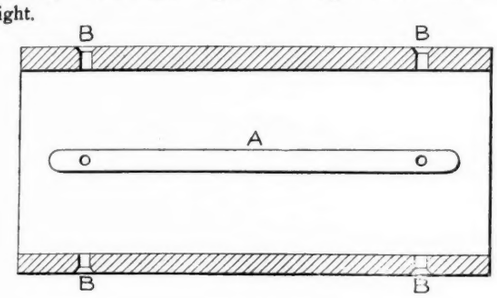


FIG. 6.

It is bored and reamed to a working fit on the shaft, and also turned to a free fit in the pulley.

The oil grooves B, B, Fig. 6, are cut around the outside of the bushing to suit the oil holes in the pulley, so that at whatever position the bushing may take in the pulley the oil will readily flow to the bearing. Four grooves, as at A, are cut on the inside of the bushing to within ¼ inch of the ends.

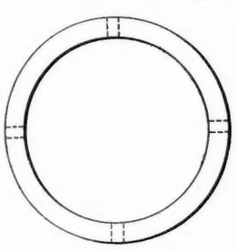


FIG. 7.

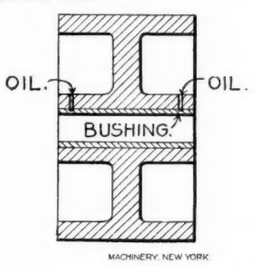


FIG. 8.

Fig.8 gives a sectional view of the pulley with the bushing in position, which is made so that its length is about 1-32 of an inch less than the hub and Fig. 7 is an enlarged view of one end of the bushing.

One thing to be observed in making bushings of this style is to be sure and drill the oil holes of a generous size, as they will sometimes clog with gum if allowed to run too long between oilings.

HOLDER FOR A BORING TOOL.

A writer, who wishes to be known as "Subscriber," sends sketches of a form of boring tool that should commend itself to every machinist. So often we see small work bored on the lathe with slender, pipe-stem tools, and the result is poor in accuracy and time required for the job. He writes:

Fig. 9 shows a tool holder that I have used for six or eight years, and it also shows a form of boring tool, as I make them. Also send you a blue print, Fig. 10, of a holder made for a Henry Norton lathe, which will take any tool up to 1⅝ inches diameter and down to ⅜ inch diameter, either round, flat or square.

Persons who make a tool holder like this will find it a good thing, and need never complain about springing with the cut. The cutter bars may be used short or long, as the case may be.

In Fig. 9 I show a view of a tool in a ⅝-inch hole, which may look a little odd to machinists, but will explain it, so as to make them understand the reason for the strange appearance. First, the center of the holder must be the height of the centers

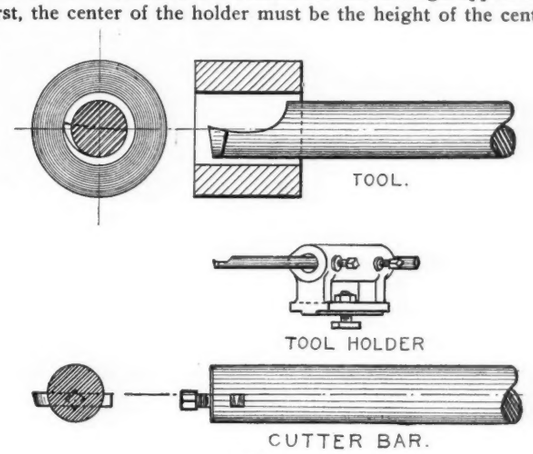


FIG. 9.

of the lathe, then the tool, which is of round steel, is cut down to the center on the cutting edge, but back of this point is made lower so as to give a lip. Now, if the tool is put in the holder it will come in the center of the hole, up and down, and if required to have more lip, it is only neceseary to turn the tool upward a little, as shown in the sketch.

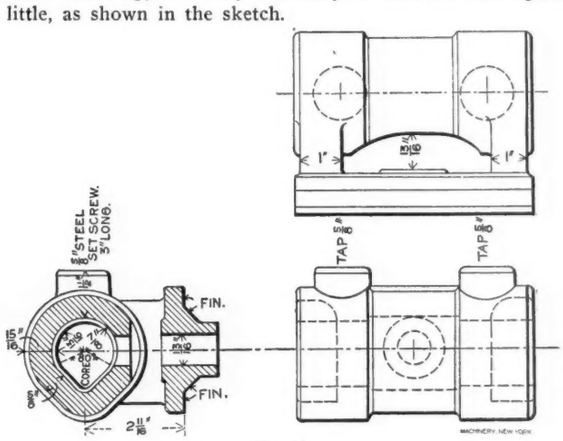


FIG. 10.

It will be seen from the view that it is a big strong tool in such a small hole, as compared with one of the old style tools made of flat steel. The cutter bar should be made as shown, with the cutter below the center, for the reason stated above.

* * *

Nearly forty years ago Mr. D. K. Clark testified to the "advantage of rapid, or, rather, intense draft, in perfecting combustion and extinguishing smoke," upon which Mr. C. Wye Williams was led to remark: "But the difficulty lies in the obtaining of this 'intense draft.' * * * The absolute command of draft for the generation of the required quantity of steam, to enable the engines to work their full power, being then so essential, it becomes a question of whether other means than the natural draft should not be resorted to; since, independently of the uncertainty in the amount of draft, and the consequent irregularity in the working effect of the engines, the cost of sustaining that draft may be so much in excess of what an artificial draft would be. M. Peclet also at this time investigated the subject, showed the low efficiency of the chimney, as compared with a fan, and recommended the use of rotary fans, applied for exhausting on the induced system."

* * *

Be sure that all bearings have generous oil grooves cut from the oil holes. Do not make the mistake of thinking that because the bearing is small or unimportant it will give no trouble.

LETTERS UPON PRACTICAL SUBJECTS.

MEMORANDUM UPON MECHANICS' WAGES IN EUROPE.

Editor MACHINERY:

In a paper read in this city by William C. Redfield, on "The Ethics of Employment," before the Church Association for the Advancement of the Interests of Labor," the following words occur:

"It is not the rate of wages that governs the cost of production, but chiefly the rate of production; and if wages be low and production slow, the labor cost will be high."

These few words explain fully the fact that American manufacturers can compete with the work produced abroad in spite of the fact that labor, which is one of the great items in the manufacture of machines, is so much lower there than here.

During a lengthy stay in Europe, and while traveling in the interest of both American and European manufacturers, I was often called upon to explain the seeming inconsistency of these conditions.

In looking over some papers I recently came across some notes which I had made on average wages, as paid in the French and German manufacturing establishments. The amounts named in the list below are averages, and represent the wages for a day of ten hours. In the compiling of these averages, the wages of the foreman or sub-foreman have not been considered. They represent the average prices paid in an establishment for general machine tool manufacture, employing about seven hundred or eight hundred men, and having a reputation for good work. Below is the list:

MACHINE SHOP.

Lathe hands	61.8 cents
Planer hands	60.0 cents
Machine work—milling machine, drilling machine, screw machine, etc.	58.2 cents
Assembling	60.8 cents
Blacksmith	68.6 cents
Patternmaker	68.6 cents
Floorhand, or helper	56.6 cents

IRON FOUNDRY.

Moulder	68.2 cents
Helper	53.0 cents
Cleaning castings	57.2 cents

These figures may prove interesting to some readers. The first impression anybody would have from the figures would be that in Europe machinery can be manufactured so much cheaper than in the States, where the wages are from two and one-half to three times higher. This conclusion would, no doubt, be correct, provided that the rate of production would be the same in Europe as it is here. Now the fact remains that machines produced here can and do easily compete in European markets, and the only conclusion possible from this very evident fact is that the rate of production must be very low, and that, therefore, in spite of low wages, the labor cost will be high, as Mr. Redfield very aptly remarked.

C. C. STUTZ.

* * *

"PRONY BRAKE TEST ERRORS."

Editor MACHINERY:

The letter under the above heading, by Bell Crank, in which he assumes that the weight of the apparatus used in Prony brake trials has a serious result upon the accuracy of these tests, has caused a friend to suggest that the method shown in Fig. 1 be employed to relieve the pulley of this weight.

For convenience, the apparatus has been shown in its simplest form, which may not be the most approved manner of attaching the friction blocks, but it will serve to illustrate the idea. The wood pieces, E and D, are clamped on the rim of the pulley C of the motor, to be tested, and the weight of these is carried by the counterweight, A, through the lever, B. The scale platform is shown at F. Now, this apparatus can be so adjusted that it will be in equilibrium, and thereby entirely relieve the pulley of all the weight of the rig, to avoid the evils mentioned, as the journals of the pulley, C, would be subjected to no downward pull, but if the weight were carried on the pulley, as is usual, would there be any such loss of indicated power as Bell Crank would have us to believe?

Suppose, that instead of the usual tension apparatus used, we substitute the one shown in Fig. 2. Here we have a wooden beam, H, whose weight may be called 200 pounds. The two weights, W and W, are so suspended that the whole rig is in balance, resting upon the rim of the pulley, G. Now, the dead weight is 1,200 pounds, and if we take Bell Crank's coefficient of friction, it is clear that the pulley will resist rotation at its rim with a resistance of $1{,}200 \times .2 = 240$ pounds. Taking the diameter of the pulley to be 2 feet, and the distance from the shaft center of the fulcrum on the scale platform, J, to be 5 feet, it is certain that with the pulley turning, as shown by the arrow, there would be $240 \div 5 = 48$ pounds indicated by the scale beam.

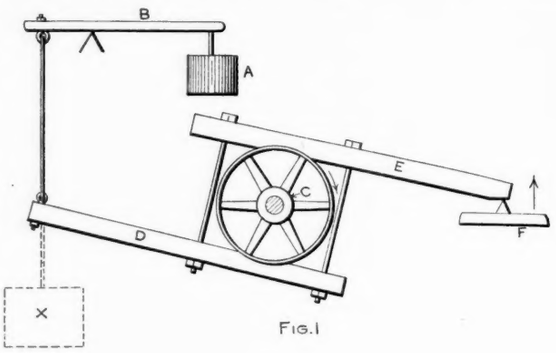


FIG. 1

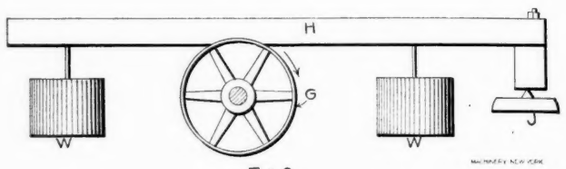


FIG 2

Here we have a Prony brake that depends solely on the weight of the apparatus, multiplied by the coefficient of friction to record the moment of resistance, and aside from the loss caused by the excessive weight of the rig upon the journals. it is perfectly reliable.

That which is desirable in this test, however, is to relieve the journal of weight, and the effect of the torsional strain of the brake beam bearing upon the scale. We should, to realize the best results, endeavor to get a statical couple, so that when the pulley is rotating under load no abnormal effect is brought upon the journal, but the lifting strain should be balanced by a counterweight, X, shown by dotted lines in Fig. 1, and without the weight, A, and connections. A little reflection will show that when X = weight, indicated at F, the upward and downward forces at C are balanced, and we have the most favorable conditions possible, as he journal carries practically no load.

This condition is superior to that usually met in practice, so that it seems that the ordinary method, taken altogether, about fulfills the average requirements, unless very refined results are wanted.

F. E. R.

* * *

STARTING AND STOPPING A BOILER TEST.

Editor MACHINERY:

I note in your February issue a review of Prof. Spangler's paper on boiler tests, and especially the reference to his method of starting and stopping the test.

I agree most fully with his condemnation of the so-called standard method of drawing the fire at the beginning and end of the run. This drawing of the fire, re-building with wood, etc., introduces such a disturbance of the normal conditions as to cause in most cases a greater error than it eliminates. Where mechanical stokers are used the difficulty is even greater.

In any commercial test there should be a running start and a running finish, under normal conditions, and the longer the test the less the error. No boiler test should be of less than ten hours' duration, while twenty or twenty-four is a much more satisfactory number.

For several years past I have used a method of starting and

stopping which has proved satisfactory, especially when a mechanical stoker is employed.

In the first place, the entire plant should be running under normal conditions for several hours before the test. For four or five hours after starting a fire, even if the boilers are warm, the rate of evaporation is below the normal, on account of the heat absorbed by the brick work and the foundation. This is especially true in the winter time.

About half an hour before the time of beginning the test the feed of coal to the hopper is stopped, the hopper is allowed to empty itself, and the opening closed with an iron plate. (This when a stoker is used). The feed of coal down the grate is continued at the usual rate, thus gradually thinning the fire. During this interval the clinkers and ashes are cleaned out and the ash-pit swept perfectly clean. The exact time of cleaning must be noted. Meantime the water level is brought to the desired point. The steam guage is carefully watched until the pressure begins to fall. The pressure is allowed to fall a definite amount, perhaps five or ten pounds. This shows that not only has the coal run short, but the heat of the furnace diminished.

At this time the fire is examined as an additional precaution. The test is then begun promptly and continued in the usual manner, the fires being cleaned and the ashes weighed at the usual intervals.

As the time approaches for closing the test the water is brought to the proper level and carefully kept there by manipulation of the pump and valves. Exactly the same course is then pursued as at the beginning of the test; the coal feed is stopped, the fires are cleaned, the grates and guage are watched, and when the pressure has fallen the same amount as at the start the test is stopped.

If hand firing is the rule the same principles apply; i. e., stop putting on fresh coal, keep the fire even, and clean and let it burn itself out until the pressure has fallen a certain amount; then start the test promptly, putting on coal gradually and forcing the fire to prevent further fall of pressure. Repeat the procedure exactly at end of test.

In starting and stopping in this way I l 'v more upon the fall of pressure, as an index of the heat condition. than upon the appearance of the fire itself, although the latter should be observed as an additional precaution.

What is most needed now is some reliable standard method of sampling coal and determining the percentage of moisture. I do not mean that it is desirable or necessary to do this by laboratory methods, but some simple and convenient method which will give the same relative results in different cases should be adopted by common consent.

It is all very well to say that the coal should not be wet; it frequently is wet, and sometimes wetter in one part of the bin than in another. I have followed a common practice of spreading ten pounds in a shallow box, putting it on top of the boiler and allowing it to remain twenty-four hours.

This is not satisfactory, and an error of one or two per cent. in the determination of moisture affects the whole test.

C. H. Benjamin.

* * *

BAD FOR THIEVES.

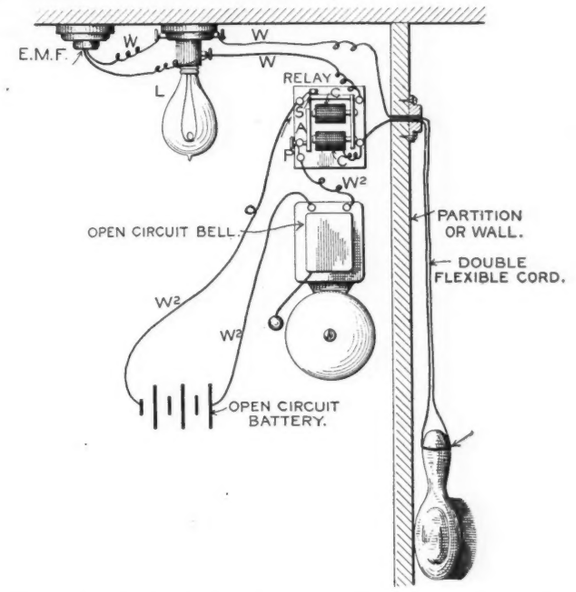
Editor Machinery:

I have charge of the steam and electrical plant and appliances of one of the leading hotels of Detroit, Mich., and, although the subject that I am going to write about does not strictly come under the head of steam engineering, yet there may be others in our profession who may find themselves placed in similar circumstances, and it is for their benefit that I undertake this article. Like some of your correspondents, I lay no claim to originality; I merely apply an old system to a new use, or one which is new to me.

When I first assumed my duties here we were much annoyed by having the combs and brushes cut from their chains in the public toilet rooms, and carried away by unscrupulous persons, either as souvenirs, or to fit up their own rooms, and the management could never catch the thieves or find any remedy.

How I not only caught the thieves, but saved the combs and brushes, will be made plain by the following:

Referring to the drawing, E M F is a source of constant supply of electric current, which is shown to be an incandescent lamp cutout, but which may be two or three cells of gravity battery, or its equivalent for closed circuit work. L is a 16 candle-power lamp, which, in case the lighting current is used, is in series with the other apparatus, and acts as a resistance. W W W are wires connecting E M F, through L, thence through the magnets. C C, of the relay, to the flexible double cord. Now, it will be readily seen that while a current is flowing through the magnets. C C, the armature A will be attracted and held away from contact post P, thus leaving the auxiliary, or bell circuit, open, including the open circuit battery, wires W_2 W_2, armature A, contact screw P and open circuit bell shown.



Now, should the double flexible cord carrying the comb or brush be cut, or otherwise severed, the closed circuit described will be opened, and the magnets C C will release the armature. A, which, actuated by the spring S, will immediately come in contact with post. P, closing the auxiliary circuit through the open circuit bell, which will ring until attention is called to it and the thief. In case a fuse should blow, or where gravity batteries are used, and they grow weak, or the circuit become broken through any means, the ringing of the bell will at once call attention to the defect. The system may be tested occasionally by extinguishing lamp L.

I might add that the relay may be easily made from a common open circuit bell, with the connections changed as shown in diagram, and an extra pair of binding posts added. Any number of articles may be connected up, so long as they are all in series, i. e., the current forced to travel through each conductor supporting them, in turn, so that breaking any one will open the relay circuit.

F. A. Calkins.

Detroit, Mich.

* * *

THE METRIC SYSTEM AGAIN.

Editor Machinery:

It is worthy of note that those who wish to force the metric system down our throats, when we will not take it of our own accord, are quite likely to base their reasoning upon inaccurate statements.

Mr. A. Knudsen is no exception in this matter, and we will examine what he says: "The metric system * * *, but none can deny that its decimal part entirely fills the bill!" Whew! What a whopper! As a matter of plain fact, the decimal part of the metric system is nowhere in use in mechanical engineering. Some time since I wrote some circulars about my machines, the dimensions being carefully expressed in the metric decimal system, but on their arrival in France they were thrown into the waste basket by our agent, who sent instructions to express the measures in millimeters, with no decimal point. Since then, I have frequently seen foreign blue-prints, and I find that the custom in metric countries is precisely in accord with Dr. Sellers' statement, made nearly twenty years ago. The danger of error by the use of the decimal point has forced the metric countries to give it up, and they have adopted a new base, not the meter, but the millimeter. In other words, they have taken, say, a

thirty-second of an inch as their unit, and express their dimensions in so many thirty-seconds.

The decimal part, which, according to Mr. Knudsen, entirely fills the bill, in fact has been entirely abandoned. Is there one large establishment in the world building machinery where the dimensions are given in the metric decimal system? I hope Mr. Knudsen will not let the silence grow oppressive.

"It is useless to try," he says further on, "to convince any thinking mind that decimal division and computation are wrong (no one ever dreamt of trying such a thing) in a century when decimal arithmetic is at the base of the entire social compact, and in a country where all instruments of precision, from dollars to micrometers, are divided decimally." This is mighty pretty writing, but it is not accurate. If by "social compact" Mr. Knudsen refers to the business of daily life, he is so obviously wrong that it is not worth while to go into particulars. The danger of discussing whether the dollar is an instrument of precision is too great for me to run into it; but I would timidly suggest that all instruments of precision are not divided decimally.

Mr. Knudsen adds to his note that a certain firm uses the metric system. If they do, I beg them to accept my expressions of profound and heartfelt sympathy; but, as a matter of fact, do they, Mr. Knudsen? Do you use bolts and screws in these shops? Which one of the sixteen, or is it one hundred and sixty, metric screw thread systems do you use? Don't you use, in fact, the system of the learned Dr. Sellers? How about your pipes? What a delightful time you must be enjoying with your pipe threads. Your arbors and your reamers also. Which one of the infinite systems for these, in use in metric countries, have you seen fit to adopt? In fact, don't you use the usual United States systems, merely expressing your sizes in millimeters?

There is but one sound argument in favor of the metric system, that uniformity with the nations of Europe is desirable. But let the metric nations begin by being uniform with each other. When we read that there is to be a meeting in Switzerland, so chosen to avoid jealousy, in order to decide upon a system of screw threads; and we learn, moreover, that the metric screw thread systems can be counted by the dozen, and that those considered the most practical and most acceptable are nearly identical with our own Sellers' system, we ought to hesitate a little. Let us wait until we can see the metric nations agree among themselves about their pipes and fittings, their bolts and nuts, cap screws and machine screws, and the thousand little things which we have standardized for our machine construction so well and so easily.

Let us watch and see which system will wear best. That's the final argument. To-day the best of the argument is on our side, for our work is going to every part of the globe.

In conclusion, I wish I could find words strong enough to condemn the mischievous cranks who, unable to convince their hearers by fair argument, resort to legislation to force their notions upon us.

ACCURACY.

Newark, N. J.

* * *

SECTION LINING AND SECTION LINERS.

Editor MACHINERY:

We see occasionally in mechanical papers new devices for section lining instruments. These, as a rule, illustrate some draughtsman's pet hobby in that direction. Up to the present time I have found no use for a section liner, a steady hand and a trained eye having met all the requirements, and it has been my experience that it took longer to manipulate the instrument than to regulate the section by the eye, and with no apparent benefit to the appearance of the drawing.

I have noticed that, as a rule, a 45 degree triangle is used in section lining. Did you ever stop to think that in some cases this is proper, while in others it is a waste of time? Suppose we take the section of a hollow cylinder, as shown in Fig. 1. It must be admitted that it will take more lines, more time, and more patience, if the lines are drawn vertical than though they are drawn horizontal, provided the spacing between the lines is the same in each case. Not that I should advise the use of either of these styles in sectioning, but as a medium between the two instead of the 45 degrees triangle I should use the 30 degrees, for it will take less lines and cost less money than though the 45 degrees was used.

In brown paper sketches and layouts some draughtsmen use the utmost care to get the sectioning even, some of them using the patent section line for the purpose.

Why not draw the section free hand in these cases. If the section is small, the lines may be drawn straight enough; if the surface is large, section lines may be drawn on the boundary lines, as shown in sketch. These may be drawn quickly and answer the purpose fully, as well as though drawn with a section

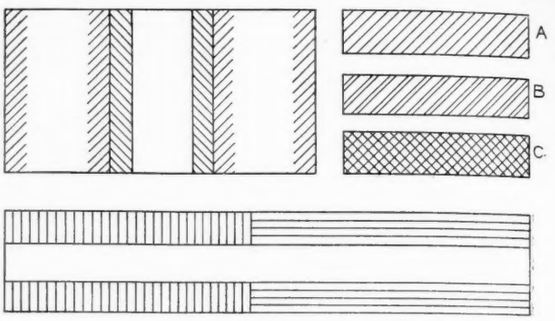


FIG. 1.

liner. The use of different styles of sections to distinguish different metals is a good idea, but do not use different sections for wrought iron, machine steel, tool steel, etc.

I think that the different styles will be found sufficient, one for cast iron, malleable iron, steel castings, etc., and all forged parts. One also for brass, bronze, and similar mixtures.

There is no fixed standard for these sections, but the common practice is as shown at A, B and C.

A. B.

* * *

A FEW SHOP NOTES.

Editor MACHINERY:

During a call at a certain shop, a point brought up was the short, slow-moving feed belt, on some small stepped pulleys, which is hardly excusable is most cases. The one in question was in need of relacing, and I observed that the machinist, instead of considering the circumstances and adapting the lacing to the conditions, stretched the belt tight, which was necessary, and laced it in the usual manner with a common belt lacing, with two thicknesses on the inside of the belt. Well, what was the result? The extra thickness of the laced joint put unreasonable stress on the belt every time it went over the pulley, and the short bent of the leather caused an excessive chafing of the lacing through the holes, which quickly destroyed the belt at its weakest point. It is safe to say that the belt would have lasted twice as long if it had been laced with eel skin, which was easy

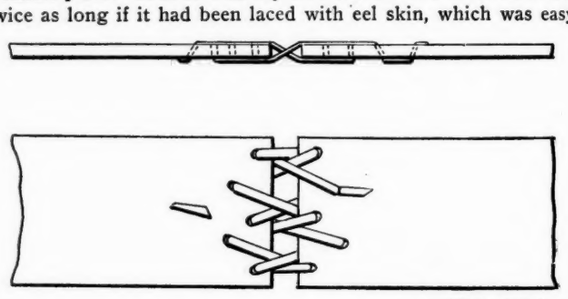


FIG. 1.

to get, in the manner shown in Fig. 1. While eelskin possesses the strength of a fiddle string, it is so thin that it does not produce much difference in the tension on the belt, and the holes in the belt need not be large enough to seriously weaken it. Crossing, as it does, from one surface of the belt to the other, between the ends, greatly reduces the chafing of the lacing through the holes as the joint passes over the pulley. I remember one case where a one-inch belt, running on a pulley about two inches in diameter, required to be laced about every five hours when the usual plan was practiced, but it frequently ran two or three days when the plan that I have suggested was adopted. This is not a new kink, but my friend had grown up in a machine shop without thinking of it, and there may be others.

During our conversation he bewailed the fact that nobody seemed to build such a machine as he would like to have in his shop, and mentioned others that were like minded. What he

wanted was an upright boring mill, on which he could turn and bore work of some two or three feet in diameter, perhaps four feet would not be too much. A radial drill was another desirable machine, but he did not have near enough work for both machines, and he feels that if these two machines could be combined in one there would be a ready market for them. It would be interesting to know what the readers of MACHINERY think of combining the features of a radial drill and upright boring mill in the same machine. The idea is shown at Fig. 2, in which A is

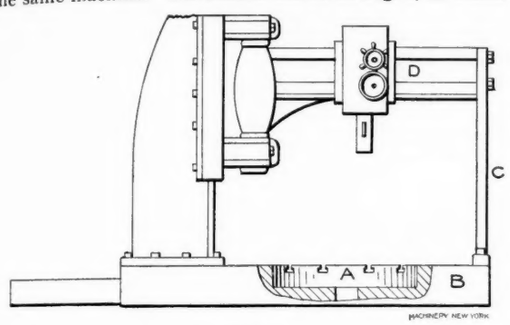


FIG. 2.

a power-driven table that is flush with the bed, B. The radial arm, D, when to be used for boring, would need a brace similar to C to stiffen and hold it in position.

Fig. 3 shows a ball-bearing truck, and the position in which it is used. These trucks work to his entire satisfaction, but the steel rollers must run true, and he seems to favor purchasing them from some company possessing better facilities for their production. This is a practical problem, and here are the ques-

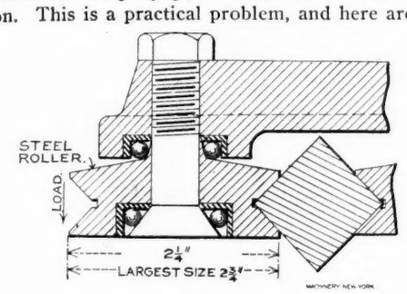


FIG. 3.

tions that arose in connection with it. What is the cheapest plan of making them in an ordinary machine shop? Would it be practicable to make them from the bar, on a screw machine, and if so, is there one made that will take a bar of the required size—2¼ inches or 2¾ inches. Answers will be watched for with interest. A. L. G.

[In connection with the combined radial drill and boring machine, shown in Fig. 2, it might be of considerable value in some cases to have the revolving table, A, provided with a simple index, so that the drilling of holes in a circle could be facilitated. —EDITOR.]

* * *

ABOUT CIRCULATION.

Editor MACHINERY:

Dear Sir: A number of us were recently discussing the relative circulation of the mechanical papers we are familiar with, and found that we really had no information on the subject, so I am taking the liberty to ask you a few questions thereon.

What is the present circulation of MACHINERY, and how does it compare with that of the "American Machinist," which I am told. is over 60,000? Is the circulation of the latter more than it was under the old management? The "Iron Age" is a paper I often see in offices, but seldom in shops—what is its circulation?

I once received among some samples a copy of your paper, with the title AMERICAN MACHINERY. What is your object in using that title for part of your edition?

If you don't like answering these questions, let them pass, as they do not come strictly in the line of mechanical information.

Yours truly, A READER.

Madison, Wis., Feb. 11, 1899.

As the desired information pertains more to the business than the editorial department, this letter was handed to the publisher of MACHINERY, who replied as follows:

The regular edition of MACHINERY, now running for March, 1899, is 16,500 copies, and in future the run will be printed at the head of the editorial page each month. The circulation of the "American Machinist" never was 60,000. Under the old management it attained a circulation of about 21,000, and its present circulation, I believe, is about 12,000. The publishers of the "Iron Age," in reply to our enquiry, say that it is against their policy to state the circulation, but the regular edition is thought by competent judges to be about 7,500.

AMERICAN MACHINERY is the title of the foreign edition of this journal, which is printed on thin paper, and comprises all the reading and advertising matter in the domestic edition. After MACHINERY was started we found that a paper of the same name, devoted mainly to agricultural and mining machinery, had for some years been published in London, England; and in order to distinguish this publication from its predecessor, especially in Great Britain, where our circulation was rapidly increasing, we affixed to the title of our foreign edition the word AMERICAN.

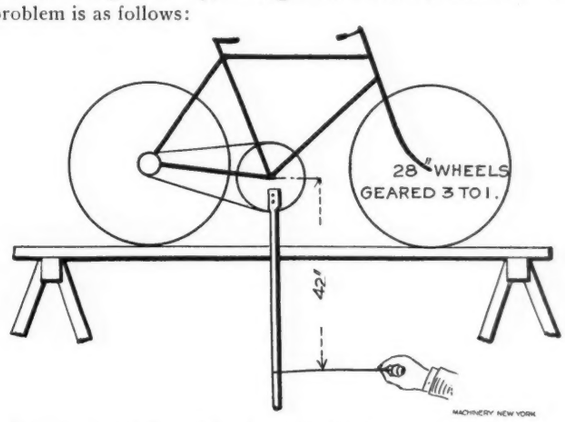
* * *

A BICYCLE PROBLEM.

Editor MACHINERY:

I was much interested in Mr. Roger's problem, relating to the countershaft and pulleys which were pulled along the floor by a rope. It will be remembered that there were two pulleys of equal diameters, which rolled on the floor, and a third, and smaller pulley for the rope, the question being to determine which way and how far the countershaft would travel.

A similar problem has been going the rounds of our shop, and has stuck a good many, athough some will not admit it. The problem is as follows:



Suppose you have a bicycle with 28-inch wheels and large and small sprockets of 24 and 8 teeth, respectively. Fasten a long bar, or lever, to the driving sprocket, and place the bicycle on a raised plank near enough to the edge, so that the lever will overhang in a vertical direction, as shown in the accompanying sketch. Question: If a cord be attached to the lever at a distaince of 42 inches from the center of the sprocket, and pulled in the direction indicated, which way will the bicycle move?

The answer is, in neither direction. It will be immovable so long as no slipping occurs. If, however, the length of the lever arm be made less than 42 inches, the bicycle will move forward, and if it be made longer than 42 inches it will move backward. I will let your readers figure it out for themselves. OLIN SNOW.

* * *

STRESS IN LOCOMOTIVE PISTON RODS.

Editor MACHINERY:

In your February issue, you quote from the "American Engineer," showing two methods of keying locomotive piston rods to their cross heads. In commenting on these methods, the types say: "In the left-hand view, the key draws the rod in place, and produces an initial strain between the shoulder and the key, which necessarily increases the tension in this part of the rod when the engine is in operaton."

This, evidently, means that the tensile strain on the rod, due to its operation, is to be added to that occasioned by the pull of the key at the point indicated. Whether this is the comment of "American Engineer" or of MACHINERY, is not quite apparent, but it is wrong in either case. Let me illustrate:

Fig. 1 shows the device in question, and we will assume that the key exerts a certain definite tensile strain of, say, 5,000 pounds on that portion of the rod from face of key to shoulder.

Let Fig. 2 be a similar device, and assume the spring also to exert a tensile strain of 5,000 pounds on the rod from the head above the spring to the shoulder. There is really no difference in the two cases, for the metal under strain in Fig. 1, may be considered as a spring, so long as its limit of elasticity is not exceeded. Let x represent that portion of the rod under initial strain in both figures. Now apply such a pull upon the rod of Fig. 2, in the direction of the arrow, as might represent an operating strain of, say, 4,000 pounds. Then we would expect the main rod to have a tensile strain of 4,000 pounds, and the part x 4,000 + 5,000 = 9,000 pounds. Very well! Let the pull be 6,000 pounds, and we would say x must be under a strain of 11,000 pounds. But this is impossible, because the pull being greater than the power of the spring, the shoulder would draw away from its seat, and x would be under no more strain than the rest of the rod, except such as would be due to its smaller section. A little consideration will show that this is the case at all times,

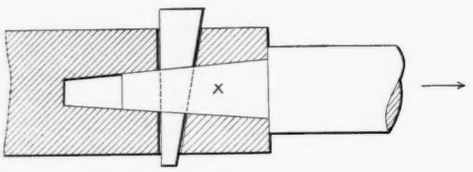


FIG. 1

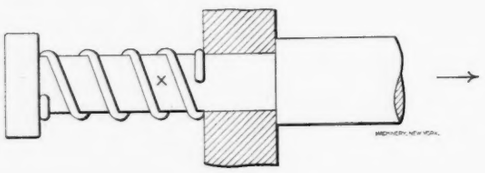


FIG. 2

and any pull in the direction of the arrow does not increase the initial strain on x until the pull exceeds the power of the spring. The same reasoning holds good in Fig. 1. When the pull on the rod becomes greater than the initial strain on x something "gives" a little, and the shoulder draws away from the crosshead a definite distance, very small, perhaps, but enough to relieve the initial strain. The whole thing is only a restatement of the old problem: Two boys pull in opposite directions on a string, each with a force of 10 pounds; how much strain is on the string? only 10 pounds, not 20.

There may be reasons why one method of keying is preferable to the other, and this criticism is only intended to apply to the particular reason cited above. FRANK E. WILDER.

Providence, R. I.

[The point brought out by our correspondent is apparently well taken, if it be assumed that the only forces acting are those due to the direct pull of the key and of the piston. Were we to turn critic of the paragraph, however, we should say that our comment erred. chiefly in being so worded as to imply that these simple conditions exist in actual practice. The most destructive element in a locomotive piston rod is the bending action, that is developed when the engine is in operation, and there can hardly be any question but that this action is more detrimental to the rod when there is an initial tension due to keying. There is undoubtedly an additional compound stress existing in the rod under these conditions. Aside from this, moreover, the initial stress is an undesirable feature, since there is no means of knowing how great it is, and there is the danger of its reaching the elastic limit of the material at the point where the key slot occurs.—EDITOR.]

* * *

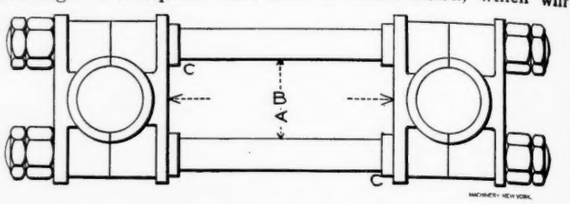
On February 5. the Franklin Institute of Philadelphia, reached the age of seventy-five years. The formal celebration of the event will be held next autumn, in connection with an exhibition of the Philadelphia Commercial Museum. Many of the discoveries and inventions which have marked the past seventy-five years as so important an epoch in the industrial world, have been first brought to attention in the building of the Franklin Institute, while the members, both individually and as an organization, have been closely identified with the industrial progress of the world during this time.

ITEMS OF MECHANICAL INTEREST.

NOTES GATHERED FROM AMONG OUR CONTEMPORARIES.

AN ENGLISH CONNECTING ROD.

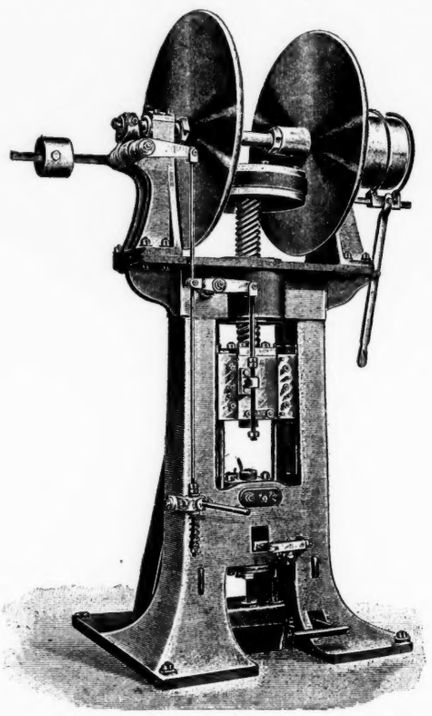
A form of connecting rod suitable for small engines and air pumps is shown in the "Mechanical World," which, from the nature of its construction will be of interest, although it cannot be indorsed as a specimen of good design. It, however, has the advantage of cheapness and ease of construction, which will



recommend it to amateurs. The sketch shows the essential parts, but if the rod be made very long a tie between the rods C C at A would probably be of advantage. A small air motor is on the market. which has connecting rods of similar construction, but the rods C C are only tension members, a piece between the brasses on the line B taking the effect of thrust.

FRICTION PRESS.

A German contemporary publishes an illustration, which we reproduce, of a type of press that is common on the other side of the Atlantic, but which is quite different from American machines of this kind. The punch or die is driven down at an increasing speed by the contact of the wheel at the top of the large, double-



thread screw, with one of the friction discs and the head is returned by a movement of the handle at the left, which operates a clutch, throwing the disc out of contact with this wheel and throwing the other into contact. The wheel between the discs is made heavy, so as to gain the impulse due to its momentum.

PIPES THAT WON'T BURST BY FREEZING.

It seems, according to the statement of a technical paper, that the wily plumber has at last been outwitted, and the partnership between him and Jack Frost dissolved, by an inventor in Germany. This paper states that the frozen water pipe is a problem that confronts almost everybody where large systems of water piping are in use. A new German invention designed to prevent this provides an opportunity for its expansion by cold. Into the iron pipe as far as it is above ground there is inserted a second narrower pipe of thin sheet tin or lead, which is filled with an elastic substance. This insertion remains unaffected by ordinary pressure, but if extreme cold should cause the water

to freeze the elastic insertion is compressed as much as the volume of water is increased by freezing. In thawing the insertion expands again to its original circumference. The tin or lead around the insertion is for the purpose of preventing the water from assuming an unpleasant taste or odor. Water pipes provided with such insertion withstood a cold test of forty degrees C., while others that were not provided with it burst every time.

A REMARKABLE FORGING.

Some interesting facts are mentioned in respect to the forgings for a new engine intended for the Boston Elevated Railroad Co., to be made by the Bethlehem Iron Co., at South Bethlehem, Pa. The shaft for the engine is to have a measurement of 27 feet and 10 inches in length and 37 inches in diameter. It will be hollow forged, having a hole 17½ inches in diameter, and the shaft, when completed, together with cranks and fly-wheel hub, will weigh upward of 150,000 pounds. In certain respects it would appear that this is to be a remarkable forging, the specifications calling, among other details of construction, for the highest grade of fluid compressed nickel steel, annealed and oil-tempered, the material also to show an elastic limit of 50,000 pounds per square inch, and an elongation of 18 per cent. in test pieces 1 inch in diameter and 10 inches long. The definite dimensions are stated to be: Diameter of fly-wheel fit, 37 inches; diameter of axial hole, 17½ inches; length over all, 27 feet and 10 inches. The estimated weight is 63,000 pounds.

GAS AND GASOLINE PUMPING PLANTS.

Gas and gasoline engines are coming into extensive use for driving pumps at railroad tank stations and other isolated plants where direct-acting steam pumps and small steam boilers have generally been employed. In another part of this issue is very complete data regarding the consumption of steam that may be expected with direct-acting steam pumps under ordinary working conditions. These pumps are simple, easily taken care of, easily regulated to any desired water supply within their limits and find favor for innumerable uses for these reasons. They have the disadvantage, however, of requiring a cylinder full of steam at each stroke, which is thrown away at exhaust at the same pressure at which it is admitted to the cylinder. They cannot take advantage of the expansive force of steam without the use of a flywheel or some compensating device which is not deemed desirable with pumps of small power, since simplicity is considered to be so important a feature.

In the Journal of the Worcester Polytechnic for January is an article by Chas. O. Rogers, summarizing the results of several tests upon a number of different pumping plants operated by gas or gasoline. In connection with the data mentioned upon the performance of direct-acting steam pumps, a few figures taken from these results will be of value as a basis upon which to estimate the probable relative cost of power pumps run by gas or gasoline, and direct-acting pumps run by steam.

SUMMARY OF TESTS

Engine.	Pump.	Water Column H.P.	Gas Consumed per H.P.	Gasoline Consumed Per H.P. Hour.
25 H.P.....	8½"x8" single acting triplex.	16.03	16.28 cu.ft.	
35 H.P.....	8½"x8" triplex	26.68	17.64 cu. ft.	
10 H.P.....	5½"x8" triplex	6.4		.247
5 H.P.....	5½"x8" triplex	2.51		.312
6 H.P.....	7"x8" triplex	3.78		.47 (crude oil)

These comparisons cover merely the fuel consumption and do not take account of other important considerations. Regarding durability and repairs, the gas engine in its present form is not yet sufficiently aged to speak from experience. With intelligent use, it promises to be easy of maintenance. Strong points in its favor are that water can be forced into its mains in case of emergency at once, without waiting for banked fires to revive. Fuel consumption ceases at once when the engine stops, and all fuel and waste are automatically taken care of by the machine itself.

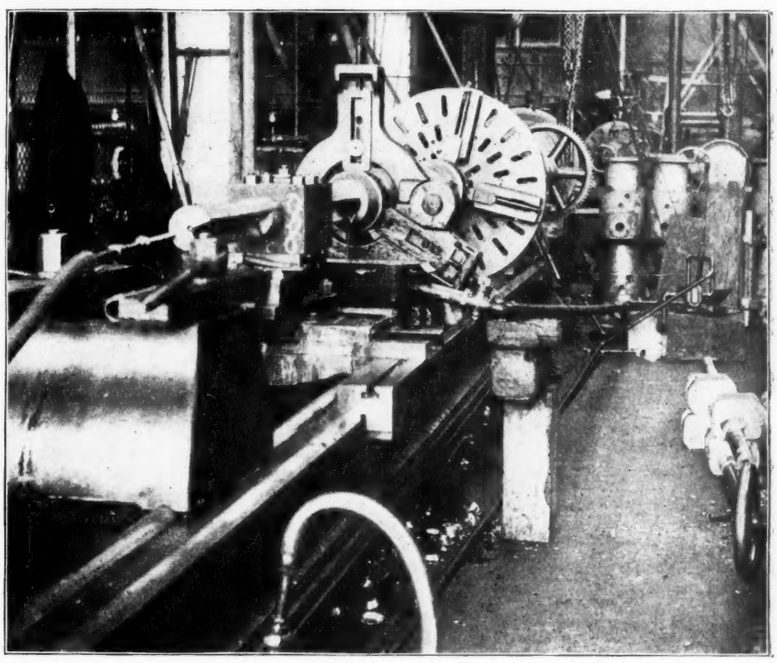
* * *

BORING LONG HOLES.

Boring a long hole in steel or iron is an interesting piece of work and one that many mechanics would hesitate to undertake. Knowing that the Westinghouse Machine Co. have a great deal of this to do in connection with the shafts for their large engines, we wrote them asking for particulars as to apparatus and methods, and received the following letter and photograph in reply.

Editor MACHINERY:

Some time ago you asked us for a description of how we put a small hole through a long engine shaft. The enclosed photograph shows how we do it. The hole here photographed is 4 in. diameter, and the shaft which is being so bored is about 7 feet long. A step cutter is secured to the cutting nose of the bar and it breaks up the chips into narrow limits so that they can be easily washed out through the quadrant-like channel made for that purpose. The hole is started with an ordinary tool for 2 in. or 3 in. in depth. As shown, the bar is clamped in a centered block, which supersedes the tool-post for the time, The ordinary carriage feed is employed in small holes, and in boring big holes we supplement this with a jack screw. The little pump in the distance keeps a stream of oil on the cutting steel, and also washes out the chips. The lathe shown is 40 in. swing. The cut is fairly self-explanatory.



BORING A LONG HOLE.

Yours truly,
THE WESTINGHOUSE MACHINE CO.,
(Signed) W. A. BOLE, Superintendent.

* * *

THE "Scientific American" has given, in a number of late issues, photographs and descriptions of the manifest frauds found in the laboratory of the late John W. Keely, of Keely motor fame. These exposures can leave no doubt as to the double dealing of Keely, but it will be a question to many as to whether he really had made any discovery or not. Some argue that, having made an important discovery, he used the methods of the charlatan to gain funds for the prosecution of his various enterprises. He was certainly a success in gaining the credence of the public, and often of men who have repute as to learning and ability. His command of a jargon of semi-scientific and outlandish talk was simply superb, and probably was a powerful factor in gaining the support of many.

SOME NOTES GATHERED AT THE LATE BICYCLE SHOW.

The variety and number of wheels shown at the late bicycle and automobile show at Madison Square Garden was both interesting and somewhat confusing to one who went there with the idea of choosing a mount. A prospective buyer would have considerable trouble to settle on any particular model, as the great display of desirable wheels at almost any price would cause a reluctance to choose any one as being superior to another, when price and finish were considered.

Chain and chainless, single and tandem, sextuplet and septuplet were there, to say nothing of some queer machines designed for hill climbing. With the latter, the well-worn phrase of "gain of power" was used, but it is hard to see how a multiplicity of parts can be of any advantage, as long as it is a well-known fact that simplicity of construction is the ideal one to attain in a machine from which we are to get the greatest efficiency.

One novelty shown was a chainless tandem, for which the claim was made that it was the only one in the market, and the writer will venture to wager that its number will not be greatly multiplied by those who have any fears of that "tired feeling." The single wheel of the same make, with the chainless feature, was the subject of much interest, and, judging from the "bottled enthusiasm" of the representatives in the booth, there is millions in it, but enthusiasm soon cools with the weary bicycler, miles from home, who feels that he is wasting energy with every rotation of the cranks.

The Columbia exhibit was, as usual, strictly first-class, and of particular interest, as a number of their automobiles were shown, of various patterns.

One of these was a carrier designed for the delivery of parcels, and if the price of this useful machine is within reasonable limits there seems to be a good opening for them in cities and large towns. The pleasure carriages made by this company are, however, beyond the reach of any but the well-to-do, and with this class fashion as yet has not said that they are the correct thing.

The electric cabs doing a passenger service in New York City are paving the way to a more general use of this means of transportation, however, and in the heavy snows of February they appeared to have some advantages over carriages drawn by horses. One disagreeable feature of these machines is the grinding of gears, resembling in a minor degree the sound of the agriculturist's mowing machine.

It may be, however, only a matter of a few years when the conditions prevailing already in Stuttgart, Bavaria, will obtain on the principal streets. The Municipal Council of that city, according to the statement of a contemporary, has passed a law forbidding the use of horses for trucks or heavy freight wagons within the city limits. The advantages that will result from the adoption of some practical system of motor-driven trucks are very desirable, aside from a humanitarian point of view, as the noise and confusion incident to the crowded condition of the streets in large cities will be greatly lessened, and the use of asphalt or some smooth paving will be general. With these conditions street cleaning will be an easily handled job, as the accumulations of debris and filth will be greatly lessened, and the smooth surface greatly facilitates the cleaning operations. In fact, flushing from the hydrants in many cases would accomplish every purpose.

An electric phaeton was in operation in the basement at the exhibition, and many of the visitors availed themselves of the opportunity offered of a free ride in it. The price of this machine was stated to be $2,200, and as they carry heavy storage batteries, which are easily ruined, it is clear that they will require much cheapening in price before they can become generally adopted. None of the steam or gasoline motors were on trial.

A feature of the Orient septuplet is a chain adjustment between each crank hanger, which is quite essential, when instead of seven riders the machine is built for ten. The latter is called a decemtuplet, and the claim is made that under favorable circumstances a speed of one mile per minute can be attained with this monstrous machine.

The chainless wheel is coming in favor, and the ones which will undoubtedly prove popular this year will be those fitted with the Sager gear. The chief claims made for this novel form of gearing are freedom from friction of approach, line contact between the opposing surfaces, freedom from end pressure on the bearings and adjustability of the parts. The latter is of manifest advantage, as in no form of practical bicycle construction can the springing of the frame be entirely eliminated, and any design of gearing which will not accommodate itself to the springing of parts will necessarily prove a failure. Another advantage of this gear is that the teeth can be cut theoretically correct with a very simple mechanism. The rollers replaced by milling cutters of the same dimensions, and operating on the opposing blank, which should be turned at the proper pitch speed, would generate the correct tooth face, and the problem presents few mechanical difficulties.

The Bullis gear and the "spin roller" gear were also shown, but with these there is only point contact, which would not appear in the nature of things to be as durable as a gear having proper line contact, but these points will be demonstrated by actual trial by the public.

The Bi-Gear was represented with models of the device, by which the choice of two speeds is given to the rider. In the highest gear the machine runs simple, but in the lower ratio, by a simple arrangement of epicycloidal gearing, the speed is accommodated to rough roads or hills.

One of the novelties in bicycle headlights shown was one which burned gas, and which had no protecting glass in front of the flame. The light burned with such persistency that it was impossible to blow it out with the breath, and it is said that the strongest tempest will not extinguish it.

"Tires Inflated, 1 Cent," is the sign borne by an automatic machine for furnishing the lazy wheelman's tires with the requisite stuffing for easy riding. If the machine would carry with the inflation guarantee that it would last to the end of the trip, there would be business for one on every street corner.

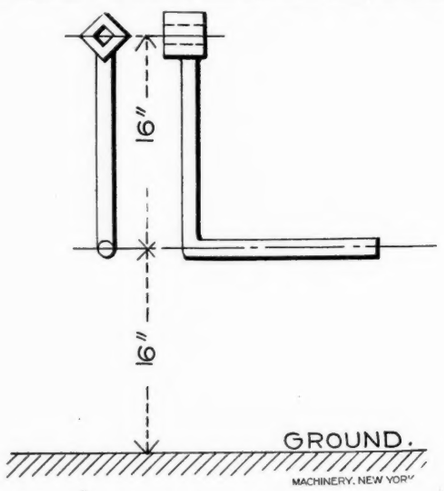
An exhibit that was of special interest was that of the Niles Tool Works, who showed their new system of polishing wheels.

The surprising work done with these wheels, together with their great durability, will undoubtedly cause an extensive demand for them, not only in the bicycle trade, but in all lines of manufacture which require polished work. F. E. R.

* * *

WINCH CRANK.

There is one detail in the design of light or heavy cranes that is a most important factor in the work you will get out of the men who operate the winch; that is, the handle, or crank.



After long continued use the writer has found the proportions shown in the sketch to be very satisfactory. W. W. CHISTIE.

* * *

It is stated that the Government has appropriated $25,000 for conducting experiments in aerial navigation. This risky but fascinating subject is no longer the butt of ridicule that it formerly was, as the results to be obtaned from a successful machine in times of war are so valuable that many of the European governments have already made extensive experiments in this line. The machine that proves to be a practical success, and we believe the time will come, must depend upon some mechanical construction to support it, in preference to the inflated gas bags or semi-balloons, which have been so much tried.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

64. J. A. P. asks: Do you know of any good treatise on Axiometric and Isometric projections? I am especially anxious to know of a treatise on Axiometric, as I have been able to get very little along this line.

A. There has certainly been nothing published on Axiometric projections, as it is a term that is never used so far as can be found in connection with drawings. Probably the inquiry relates to drawings where measurements are made along the axis, from the word axio, or axis, and metric, or measure. There is also very little published that is clear and concise on Isometric projections. It simply has to be culled out from among a great many other subjects wherever it appears in a book. The two following books treat somewhat of Isometric projection: "Mechanical Drawing," by Linus Faunce. Some eight or more editions of this book have been published. It treats of Isometric problems, projections of lines, surfaces and solids; Isometric and oblique projections. "A Course in Mechanical Drawing," by J. S. Reid, has lately come out, and pays especial attention to Isometric projections.

65. G. M. asks: First. How would you proceed in detail to line up your engine. Second. How can you tell when an engine is out of line, and states that he has babbited, shimmed and worked and still his engine pounds. Third. How do you figure the power of an engine? A friend did it thus: $9 \times 9 \div 4 = 20\frac{1}{4}$ H.P. Fourth. My engine runs fifty revolutions per minute and is belted to a countershaft and then to a saw, but doesn't have power to drive properly. How can I increase its power and not overtax my 42 in. by 10 ft. boiler?

A. First. Remove the piston, cross-head and connecting rod and run a fine wire through the center of the cylinder and frame of the engine, attaching one end to a stick bolted across the end of the cylinder and the other end to a fixed point beyond the frame of the engine, then bring the frame and cylinder in line. Next drop a line from the crank pin, say 3 in. from the crank face, when in the vertical position past the center line and measure accurately the distance between the two lines. Rotate the crank to first one and then the other horizontal position, and see if the distance between the lines will remain the same. If they do it is good evidence that the shaft is at right angles to the center line of the engine. Replace the piston and adjust the height of the piston and cross-head until the piston rod, in all positions of the stroke, is in the center of the guides. The above method of procedure can be followed where the engine has bored guides, otherwise modify the work to the case in hand. Second. Answer one answers question two. An engine out of line will always pound. An engine that has bearings loosely adjusted will also pound. The crank bearing is especially susceptible to pound when the least bit loose. Take it up a little at a time until it begins to warm; in other words, until you know its condition. Sometimes a loose key or bolt in a fly-wheel, or too little compression, will cause a pound. Third. See steam engine tests in October MACHINERY, 1898. There is no such rule as quoted. Speed always enters. Fourth. Speed up the engine to 100 or 150 revolutions per minute, and increase the size of driven pulley on the countershaft. If the boiler be sound it will furnish steam enough.

6. R. H. S. asks: First. What is the rule for turning cylinder rings. What should be the diameter of a 10-inch ring? Second. How is frosting put on machine tools? A. First. Most builders allow about ¼ in. for rings 8 in. to 20 in. diameter. Seaton's rule is an increase of 1 per cent of the diameter of the cylinder, or an increase of 1-10 in. for a 10-in. ring. Second. Frosting is an innovation resulting from scraped fits and is frequently an imitation of a scraped fit. There are numerous ways in which frosting is produced. One way is by use of a sharp steel scraper; another way is by use of a piece of fine emery cloth fastened to a piece of wood. Where simply the effect of a nice finish is to be produced a sand blast is used; with this process, the finer the sand the more delicate the finish. For fine finish, as found in watches, a rapidly revolving fine steel brush dipped in the flour of emery is used.

Questions 64 to 76 were answered by A. H. Eldredge; the remainder by Wm. Baxter, Jr.

67. K. W. Schnus asks: First. What is the per cent. of port opening usually adopted by high-speed Corliss engine builders? Second. How many square feet of heating per H.P. should be given in a re-heater of a high-speed engine? A. First. The per cent. of port opening will not differ from that usual with Corliss engines; see Article II. on Corliss engines in December MACHINERY. Second. The second question probably refers to some type of exhaust steam feed-water heater. Some of the best makes of feed water heaters allow approximately 3 H.P. per square foot of surface.

68. A. W. Chesterton & Co. ask: Will you kindly offer some opinion as to the cause of boiler gauge glasses being eaten away ,as shown in Fig. 1? This glass has been in use but 29 days. A. The above difficulty is one frequently met with and one difficult to prevent. The following explanation is offered. The hardest glass melts at a low temperature, and is perfectly soft at a temperature of 1,000 degrees, also at high temperatures and pressures can be dissolved by water so that especially when subjected to high temperatures and pressures the glass becomes comparatively soft and is soon cut away by the abrasive force

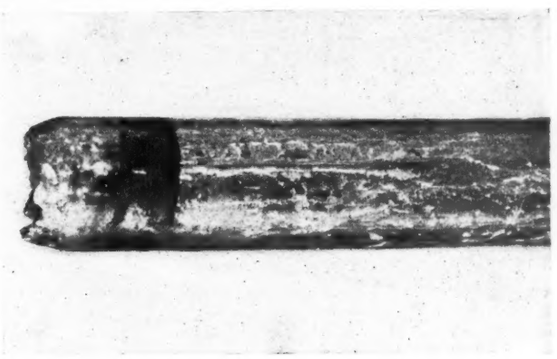


FIG. 1.

of the steam and water passing through the glass. It will be noticed that the glass is cut away on the water end and equally bad on both the outside and inside for that part projecting through the packing. Should the packing leak the same cutting away will be produced up through to the outside wherever the water escapes through the leak. Much foreign substance will help the abrasive action, while again very pure water is said to dissolve glass more quickly than ordinary water. The writer would suggest that a change of boiler connections to where the circulation is less rapid, or the use of some style a gauge glass where the water cannot get at the end to cut away on both sides, as for example the Reliance Safety Gauge Glass, might mitigate the trouble. The chemists have found that glass is soluble even in warm water.

69. G. T. asks: Please give a rule for turning taper in a lathe that has no taper attachment. A. Find the amount of taper per inch. Divide this by (2) and multiply the result by the length of mandrel. For example in Fig. 2. Total taper on piece = 1½ in. — 1 in. = ½ in.; or amount per inch = ½ ÷ 2 = ¼ in. Taper per inch on each side of center line = ¼ ÷ 2 = ⅛ in. Length of mandrel = 4 in. Total amount to set over tail stock = 4 × ⅛ = ½ in.

71. C. S. E. writes: (A) and (B) are two gears of equal diameters and the same number of teeth. (A) is a fixed gear, while (B) rotates about (A). When B rotates to (B)¹, the arrow on its edge will be found to still point toward (E). Now has (B) really revolved twice upon its own center; if so, how with

the teeth always together? A. Consider gears (A) and (B) to be locked together and to revolve about the common center (M); after passing through 180 degrees the arrow would point toward (F). At (B)[1] disconnect the gears and turn (B) upon its own center through 180 degrees, then arrow will point toward (E). Lock the gears once more and revolve about (M) to first position, and the arrow points toward (F); turn gear (B) on its own center through 180 degrees and the arrow points toward (E). This makes it evident that the gear (B) has revolved but once on its own center (M). Thus any point on gear (B) will have passed through twice 360 degrees, once about center (M) and once about center (N), so that the arrow points once for each of the compound motions toward (E).

72. B. C. writes: First. Is there any advantage in having the rim of a turbine water wheel heavy, as shown in D (Fig. 4)? Second. Is the power of the wheel increased by giving the water a considerable fall after it leaves the wheel? A. First. There might be a slight advantage in having the rim of the wheel heavy in giving it the action of a fly wheel and causing it to run a little more uniformly at changes of load and of water pressure. There would be no additional gain of power. Second. If the end of the exhaust pipe could be submerged in a pond of water so as to create a partial vacuum, it would increase the power of the wheel. Ordinarily there would be no increase of power from that source.

73. A. F. writes: Please give me a simple exact rule to figure the length of the chord (A), Fig. 5, for any given number of degrees. A. There is no simple rule for figuring the length of the chord. Probably to lay the problem out on the drawing board would be the quickest method. The versed sine of the arc (D) has to be known in order to solve for (A). Then we have:

$$A = 2\sqrt{2DB - D^2}$$

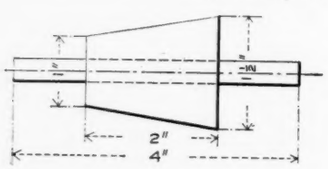


FIG.2

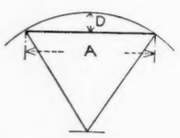


FIG.5

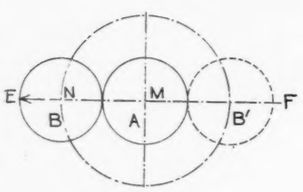


FIG.3

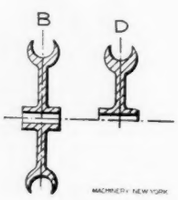


FIG.4

74. E. F .S. asks: First. Will you please give me the different sizes of steam and gas pipes and their relative carrying capacity. Second. How are valves of a duplex pump set? Third. How do you find the grate surface and size of safety valve for a given size boiler? A. First. See tables on pipe sizes in Wm. Kent's Handbook. Second. Remove steam chest cover, place piston on dead center and set valve for proper lead. Third. The grate surface is a varying quantity; it changes with the kind of fuel and kind of draft. In ordinary stationary practice, 10 lbs. of anthracite and 15 lbs. of bituminous coal per square foot of grate per hour is common practice, and will average 4 to 5 lbs. of coal per I.H.P. per hour. The common rule for size of safety valve is one square inch for 3 square feet of grate surface in fire tube boilers, and one square inch for 6 square feet of grate surface in water tube boilers.

75. I. L. P. writes: How can I harden cast steel so that it will hold an edge and not crumble? A. The method of procedure would depend on the kind of steel and the purpose for which it is to be used. For ordinary lathe and planer tools, heat the tools in a charcoal fire to a cherry red, and quench them in a hardening solution consisting of 1 gallon of soft water and one-half pint of salt.

76. A. L. D. writes: We have an oak-tanned leather belt 26 feet by 12 inch, and it cost $95. The inside of the belt for six inches has become oil-soaked, causing it to be side heavy and to run into the side of the machine. What can be done to help this case? A. Rub the belt thoroughly with fuller's earth or powdered chalk to absorb the oil, scrape off the chalk and wash it thoroughly with castile soap and warm water. Rub it with neats-foot oil, and allow the belt to dry. The above treatment will help the belt, but if it be saturated it is hardly possible to remove thoroughly the oil.

77. J. W. K. writes: I want to make some quart cells, five or six of them, of bichromate of potash, and desire the proper proportions of the elements and acids; and also whether a porous cup would be of any good or not, and how I can make them. Also let me know the kind of battery that it suitable for operating a 2 H.P. gasoline launch engine; also size of spark coil. A. The solution of bichromate batteries is made of one part of bichromate of potash to five or six of water, and after the salt has been thoroughly dissolved add ten or twelve per cent. of sulphuric acid. This solution is used without a porous cup. The latter is not necessary, except when the acid and the bichromate are kept separate, and there is no great advantage in the two liquid types. Porous cells are made of unglazed earthenware, and can be obtained at small cost from dealers in electrical supplies. Bichromate batteries are not well adapted for intermittent work, as the zinc consumes whether the battery is delivering current or not. They are principally employed for experimental work, where they are only used at long intervals, and when not in service the zinc is withdrawn from the liquid. The carbon cell, or the "Gordon," are the best suited for operating spark coils. A spark coil can be made by forming a core of iron wire, about three-quarters of an inch in diameter and eight inches long, and winding upon this No. 18 wire to a depth of about five-eights of an inch. Use this in connection with three or four carbon cells.

78. H. I. writes: I would like to ask MACHINERY how to make a perfect intensity coil, or medical battery. A. Intensity coil is one of the out-of-date names for an induction coil. The name "medical battery" is frequently applied to the complete outfit used by doctors, and which consists of an induction coil and a battery to operate it. The batteries used in connection with medical outfits are generally of the chloride of silver type. These are made by fusing the chloride around a piece of silver wire, so as to form a stick about five-sixteenths of an inch in diameter, and two to three inches long. Blotting paper is wrapped around this to a depth of about one-quarter of an inch, and outside of all is placed a sheet of zinc. The paper is saturated with a solution of chloride of ammonium, 200 grains, to one pint of water. The wad, made as above described, is placed within an open-mouthed vial about one inch in diameter and four inches long, and the wires are attached to the silver rod and the zinc plate. Such a cell is far more expensive than a dry battery, several types of which can be found in electrical supply stores at 25 to 50 cents each, and in every way, except com-

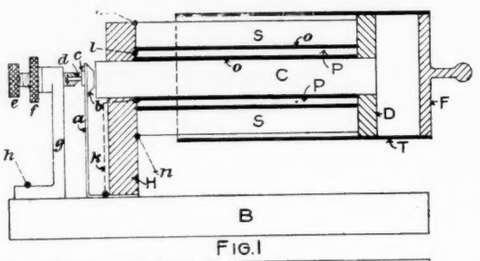


FIG.1

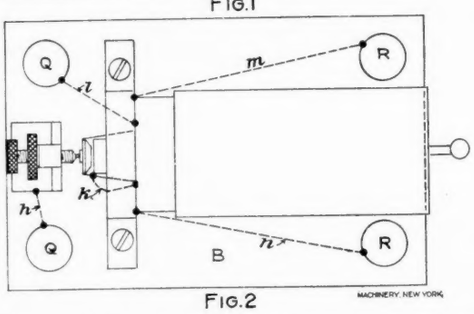
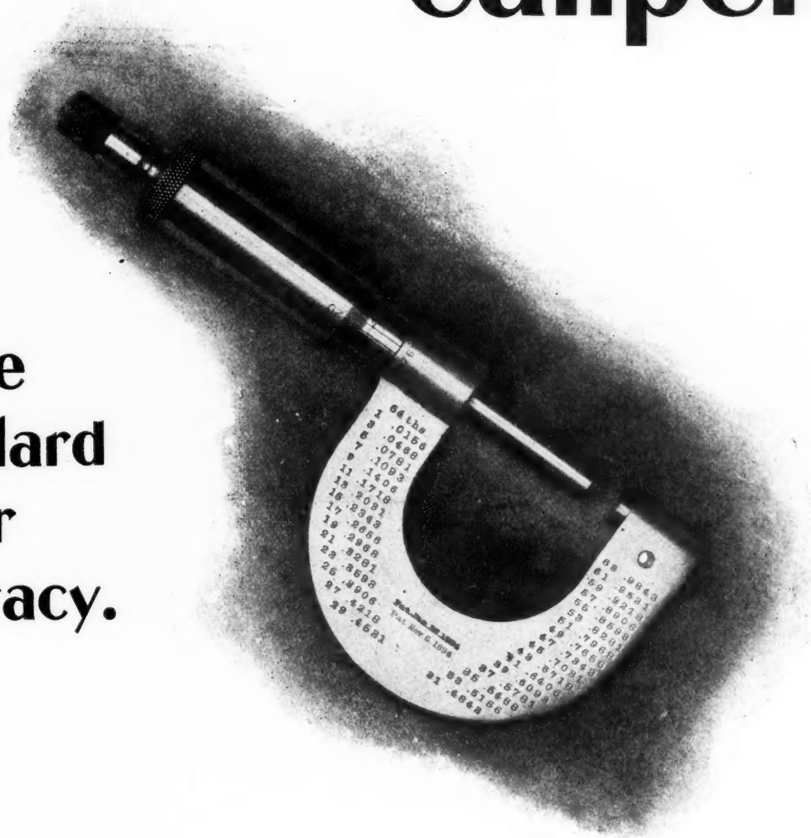


FIG.2

BROWN & SHARPE MFG. COMPANY,

Providence, R. I., U. S. A.

Micrometer Calipers.



The Standard for Accuracy.

For sale by Hardware and Supply Dealers throughout the country.

1899 Catalogue mailed to any address upon application.

pactness, it is inferior to the latter. The construction of a medical induction coil can be understood from Figs. 1 and 2, the first being a side elevation, in section, and the second a plan. C is a core built up of fine iron wire, wrapped tightly with fine cord. The space, P P, is filled with the primary wire, which is made of about No. 24. O O is insulation, to separate the wire from the core and from the secondary wire, which is wound in the spaces S S. The parts a b c d e f g constitute the circuit breaker. The battery current is connected with g, as indicated by the line h, and through point d passes to c and a, and thence by wire, k, to the primary wire, wound in spaces P P. The outside end of the primary wire leads back to the battery, as indicated by line l. The parts c and d are made of platinum, so that they may not oxidize too rapidly. The part b is made of iron, and when the current passes through the primary coil, wound in spaces P P, C becomes magnetized and attracts b, thus separating the points c and d, and breaking the current. As soon as the current breaks, C loses its magnetism ,and b flies back and restores the contact between c and d, and the current again passes through P P. This action repeats itself continually, and thereby a secondary current is induced in the wire wound in spaces S S, and this is taken off through wires n and m. In Fig. 2, Q Q are the binding posts to which the battery wires are attached, and R R are the binding posts to which the wires from the secondary coil are connected. The wires through which the shock is taken are attached to R R. The screw e and check nut f are for the purpose of adjusting the distance between b and the end of C, so that a may vibrate properly. T is a tube made of brass without a seam, and its object is to regulate the strength of the secondary current. To increase the strength the tube is withdrawn, and to reduce it the tube is shoved on as far as it will go.

---

79. B. A. B. asks: Will you please give, through the columns of your paper, the dimensions and size of wire used in a twelve-inch spark coil for igniting gas engines, and the voltage and amperage required from a battery to give good results? A. The size of wire required for the spark coil will vary with the strength of current that is to be used. Generally, these coils are made of about No. 18 B & S wire, the core being three-quarters to one inch in diameter, and the outside of the coil about two inches. The battery must be of a kind that will give a strong current; that is, it must have low internal resistance, and it must also be free from local action when on open circuit. The batteries most commonly used for this purpose are the Sampson. and the carbon batteries. To insure satisfactory results four or five cells should be employed, although three might answer very well. To ignite gas requires a considerable amount of heat, and this cannot be obtained unless the spark is produced by a current of considerable strength; that is, for a battery current. The minimum strength of current that will give positive action is probably not less than one-half of an ampere. This, however, is only an opinion, as we know of no experiments made for the purpose of determining the point.

---

80. Apprentice asks: First, How is the quantity of wire on the field determined? Second, What proportion of the current goes through the field in the shunt connection? I saw one formula, which said:

$$\frac{\text{External } R^2}{\text{Armature } R} = \text{resistance of shunt.}$$

I do not see how this can be so. For instance, if armature resistance remains constant (say 2 ohms), then for 60 volts, 15 amperes shunt will be $60 \div 15 = 4$ ohms external resistance, and $4^2 \div 4 = 8$ ohms shunt R.

And for 60 volts, 30 amperes:

$60 \div 30 = 2$ ohms external resistance, and

$2^2 \div 2 = 2$ ohms shunt resistance, thus getting twice the amperes, but only using one-quarter the wire if of the same guage.

A. There is no fixed relation between the resistance of the shunt field coils and that of the armature, neither is there such a relation between the total current and that passed through these coils. The formula you give is not correct.

The strength of the current through the shunt coils, and, therefore, the resistance of the latter, are determined by the efficiency it is desired to obtain in the generator, and are arbitrarily chosen by the designer. If the efficiency is to be 90 per cent. of the 10 per cent. loss, one designer may conclude to allow 2 per cent. for the field, and another may allow 3 per cent. The first one, to accomplish his end, will increase the armature loss, while the second will make it smaller. The number of turns of wire is determined by the strength of magnetic field required, and also by the kind of metal used, and by the length of the magnetic circuit, and the air gaps between the armature core and the faces of the pole pieces. The size of the wire must be such that the required number of turns may be obtained with the permissible resistance. To illustrate, suppose the generator is to develop an E.M.F. of 100 volts, and a current of 100 amperes at full load. Then, if the field current is to be 2 amperes, the resistance of the field coils must be 50 ohms, and if the current is to be 3 amperes, the resistance must be 33.3 ohms. If it is found that the number of turns in the first case must be 3,000 and in the second 2,000, and that one turn measures two feet, then there will have to be 6,000 feet of wire for the first case and 4,000 for the second. As the 6,000 feet must measure 50 ohms, the wire must run 120 feet per ohm. If this size wire is found to be too small to carry the current without overheating a larger size must be used, or a greater number of turns of the same size; the latter expedient is the best, as it obviates making new calculations. Increasing the number of turns reduces the current flowing through the coil, but does not materially reduce the magnetizing force, as the weaker current passes through a greater number of turns. It is not practicable to give full directions for calculating the dimensions of field coils in a short answer, but if the manner in which the number of turns in the coils is determined is understood, the foregoing will show how to obtain the resistance and size of wire. The number of turns depends upon the ampere turns required. The ampere turns are equal to the strength of the current in the field coils multiplied by the number of turns. The number of ampere turns required depends upon the cross section of the field magnets, the length of the magnetic circuit, and the density of magnetization. Tables are given in electrical books which show the number of ampere turns required per inch of length of the magnetic circuit for different densities, and by multiplying the figures obtained from these tables by the length of the magnetic circuit, the total number of ampere turns can be obtained. The ampere turns required to develop a given density vary with the kind of metal, being more for cast-iron than for mild steel, and more for the latter than for wrought iron, while air requires several hundred times as many turns as the poorest metal; hence, in determining the total number of ampere turns, the character of the metal and the length of the air spaces must be fully considered. This subject was explained in detail in the October and November, 1897, numbers of MACHINERY, in the articles upon dynamo design.

* * *

FRESH FROM THE PRESS.

A NOVEL form of sketch book, 5½ x 8½ in size, is issued by M. H. Avery, Woonsocket, R. I. It is called the Twentieth Century Sketch Book, has fifty leaves in each book, and sells for twenty-five cents. The special feature of the sketch book is that there is a scale of inches running all around the four sides of the outer edge of each page to assist in proportioning details correctly without the use of a scale. In addition to this arrangement one style of book, called Style B, has a quadrant on one corner of each page divided into half degrees. The object of this is to form a guide for drawing bevel gear blanks, and any pieces that are to be made on an angle. While this style of book will doubtless be useful after one becomes accustomed to it, we believe that a book ruled accurately into small squares, either ¼, ⅛ or 1-16 of an inch in size, would be found more convenient by the average draftsman, although both systems have their advantages and disadvantages.

CENTRIFUGAL PUMPS, TURBINES AND WATER MOTORS. By Chas. H. Innes, M.A. Published by The Technical Publishing Co., Ltd., Manchester, Eng. For sale by D. Van Nostrand Co., 23 Murray street, New York. 230 12mo pages. Second edition, illustrated. Price, $1.40 net.

The matter presented in this book is divided into seven parts. The first deals with general principles; the second with pressure engines producing rotary motion; the third with turbines whose power is obtained by altering the direction of the motion and the velocity of the water, to which has been added some information upon the Pelton water wheel. The other parts deal with Steam Turbines, the Centrifugal Pump, the Fan and the hydraulic works at Niagara. A great deal of information appears to have been condensed into little space in this book, and its comprehensive scope, including, as it does, a treatment of centrifugal pumps and fans, will commend it to many. The volume is uniform in binding and style with several other books published by the same company treating of several branches of engineering. Some of these have already been noticed in our columns.